POWER

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The Orderly Use of Time

THERE is one thing of which everybody has an equal amount, and that is time.

It is one of our principal endowments, the occasion of all of our accomplishments, acquirements and enjoyment; and we are so careless and prodigal in the use that we make of it.

Some sell it by the day or hour and are prone to measure it by the clock instead of by the progress made and work accomplished.

Some budget their money, few make an equally studied apportionment of their time. But money may be accumulated and reserved while time goes relentlessly on expending itself. The passing moment with its opportunities, its capabilities for improvement and enjoyment can never be recalled.

Just as the man who is careless and profligate in the handling of his money, who lacks wisdom and discretion in his investment and use of it, is continually in confusion and difficulty so the man who fails to employ his time to advantage not only fails in developing his possibilities but is always behindhand with the things for the doing of which he is depended upon.

And as these things, like other debts, accumulate, the lack of their doing makes the current day's work more embarrassing and difficult. The consequences of continued neglect become more widespread and serious and orderly progress becomes impossible in the scrambling attempt to avert the results of one neglect by the commission of another.

The man who goes forth into the day with an orderly program for the use of his time, who of the things to be done can choose wisely the most essential, who realizes that days are made of minutes and appreciates the amount of clearing of the ground that can be done in a few odd moments of time that would otherwise be wasted is the man whose way will be least beset by impediments and distractions, and who will be all set to take advantage of the big opportunity when it offers.

EDITORIALS

Work at Beauharnois Should Continue

FOR ABOUT two years the Beauharnois canal and power development on the St. Lawrence River, near Montreal, has been the center of attention by both engineers and laymen. The magnitude of the project places it among the great engineering achievements of modern times. It is one of three sections in the proposed plan for the river's development as a waterway for the entry of ocean-going vessels into the Great Lakes, and will also develop two-million horsepower.

Unfortunately, some of the financial aspects of this project, as brought out in a recent government investigation at Ottawa, have placed the whole enterprise under a cloud and disrupted public confidence in its promotion. Those responsible for promoting and financing the project have been accused of serious wrong in carrying out their part of the undertaking.

Be these criticisms what they may, they affect only the methods by which the project was promoted and financed. Of far greater significance is that the undertaking is correct in design and sound economically. These aspects have not been clouded by anything brought out by the investigation. When the ultimate hydro-power capacity is installed it will be one of the lowest-cost developments on this continent, besides providing a deep-water canal twenty miles long. Of the initial installation of five hundred thousand-horsepower capacity, contracts have been placed for over eighty per cent of the output. Thus the future prospect is favorable.

The engineering design and construction has been executed with a dispatch and efficiency worthy of the highest ideals of the profession. Construction is ahead of schedule on practically all sections, and if allowed to proceed at the present rate the plant will be ready for service next year at a cost considerably smaller than estimated.

There rests upon the government of Canada the responsibility that nothing shall be done to stop the work, or more serious injury may be done than has occurred from machinations of the politicians and promoters. Nearly four thousand people are now directly employed on the project. Several times that number are indirectly involved in production of the required raw and manufactured materials and in building equipment. If the investigation of the financing and promotion is to be constructive it must not cause the work to be stopped and the thousands of employees to be laid off. Beauharnois as an engineering and economic enterprise has not suffered by the investigation and should be allowed to proceed to its final completion. Any delay will only increase its cost, one of the things the investigation is intended to prevent.

The Low-Pressure Bugaboo

EVERY process industry has its low-pressure bugaboo. Look long enough and you will find some process where low-pressure steam will "never do," for some inexplicable reason. All engineering experience may point to its complete success in the particular application, but against this stands the eternal *"No"* of the operator who has been dyeing or making candy or glass or canned peaches for the past forty years. High-pressure steam has become an essential part of his routine—or, more properly, of his ritual. It is one of the sacred passes that must be made if the batch is not to be ruined. For years he has gone through a set of motions and produced a good product. Not knowing which of these motions is essential to the result, he plays safe and retains them all. One of these, much to the damage of the plant's dollar balance, is the turning on of high-pressure steam.

In each industry some man arises—generally a new man—to defy these sacred cats. His fate at times has been awful. Low-pressure steam imposed on the high-pressure devotees incites to riot. Everything goes wrong. Production falls off. Batches are spoiled, unless—and here is the secret—the engineer can disguise low-pressure steam as high.

It has been done many times with complete success. Only last week another example came to light. In a certain great factory whole batteries of similar process machines were using high-pressure steam. Moreover, their operators, backed by the departmental superin-

tendent, insisted that low pressure could not be used. The engineer, checking every factor except human nature, went ahead and installed low pressure, facing a storm of protest. At once things began to go wrong. Trouble was reported everywhere. All was lost. Whereupon the engineer gave in, supposedly, and reconnected the high-pressure steam.

Peace reigned once more. But one night, after the plant was shut down, he made secret low-pressure connections beneath the floor. And for more than a year the operators, in the bliss of ignorance, have used this disguised low-pressure steam with complete success.

Synchronous Motors on Power-House Auxiliaries

ON INDUSTRIAL loads power-factor correction has been advanced to a satisfactory state. Many plants now operate with a load power factor close to unity. This has been accomplished in a large part by selecting induction motors of correct size and characteristics for their loads and by using synchronous motors where they can be applied. While this improvement was being made in industrial-load power factor, that of the power-house auxiliary loads did not always receive due attention.

Notwithstanding that synchronous motors have been developed for practically every kind of industrial application, their use for power-house auxiliary drives is still the exception. One chief objection to such use has been that motors on these drives must not stall if a system disturbance occurs.

With some of the earlier types this objection was valid, but synchronous motors can now be had with starting and pull-out characteristics comparable with those of induction motors; and they can be depended upon to perform just as satisfactorily during system disturbances.

One of the best arguments for the good starting characteristics of the modern synchronous motor is that one rated at six-hundred horsepower is in continuous reversing service driving a copper rolling mill. This application requires that the mill be reversed from full speed in one direction to full speed in the other in five seconds. Synchronous motors are available that will operate as induction motors if pulled out of step and will pull back in again automatically when conditions become normal. Starting a modern synchronous motor is as simple as putting a squirrel-cage motor into service; and any method of starting that can be applied to one is applicable to the other.

A good power factor for the power-house auxiliary load is quite as desirable as for a load outside the plant. Power-plant designers may well adopt some of the practices of the industrial engineer to accomplish this purpose and apply synchronous motors where they can be used.

Fewer and Better Guarantees

IN THE early days of the power industry guarantees were as simple as the apparatus they covered. They merely stated in general terms the minimum of performance to be expected. It was commonly understood that the equipment could do better than this, and it usually did.

Later developments in power generation resulted in a multiplication of equipment, much of which was interrelated as to performance. The plant designer felt the necessity for information on detailed performance, that he might assemble a better-balanced plant and more closely predict its economy. The manufacturer was the logical source of these data.

Having based his plant on this information—and perhaps after one or two discouraging experiences with over-optimistic manufacturers—the engineer quite naturally sought guarantees from the equipment builders as to these detailed performance data. This was logical, but it overlooked the fact that manufacturers are constantly striving to improve their equipment and that each advance is projected from what existing equipment has done. Thus where improvements are somewhat of an experimental nature the manufacturer may deem it wise to understate his expectations and "play safe." If all the equipment builders understated to the same extent a well-balanced plant could still be assembled on the basis of their composite guarantees. But with varying degrees of caution the guaranteed performance data fail of their primary purpose.

Having guaranteed the detailed performance of his particular equipment, the manufacturer is also likely to feel that his responsibility toward the performance of the plant as a whole is limited to the details of his guarantee.

More recently there has been a noticeable tendency among some of the large buyers to request comparatively simple guarantees covering the relation of individual equipment to the plant as a whole. Detailed performance of the various parts is then left to informal discussion between the designer and the manufacturer's engineers. After all, the reputation of the manufacturer is the buyer's principal guarantee.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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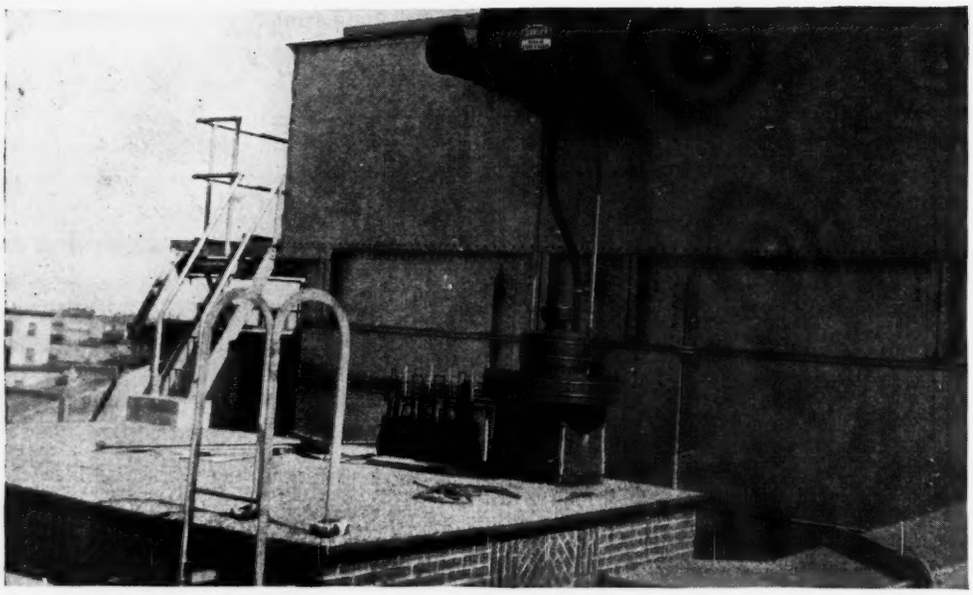
Harvard Medical Power Extension Precipitates Dust Electrically



Operating side of the electrostatic precipitator

By G. K. SAUERWEIN
Engineer
Harvard University

THE recently enlarged power plant of the Harvard Medical School protects the buildings it serves and their neighbors by electrostatic precipitation of flue dust. The new plant burns pulverized coal and includes a 1,000-kw. turbine-generator. Make-up water is evaporated and oily condensate is treated with alum and soda ash and then filtered.

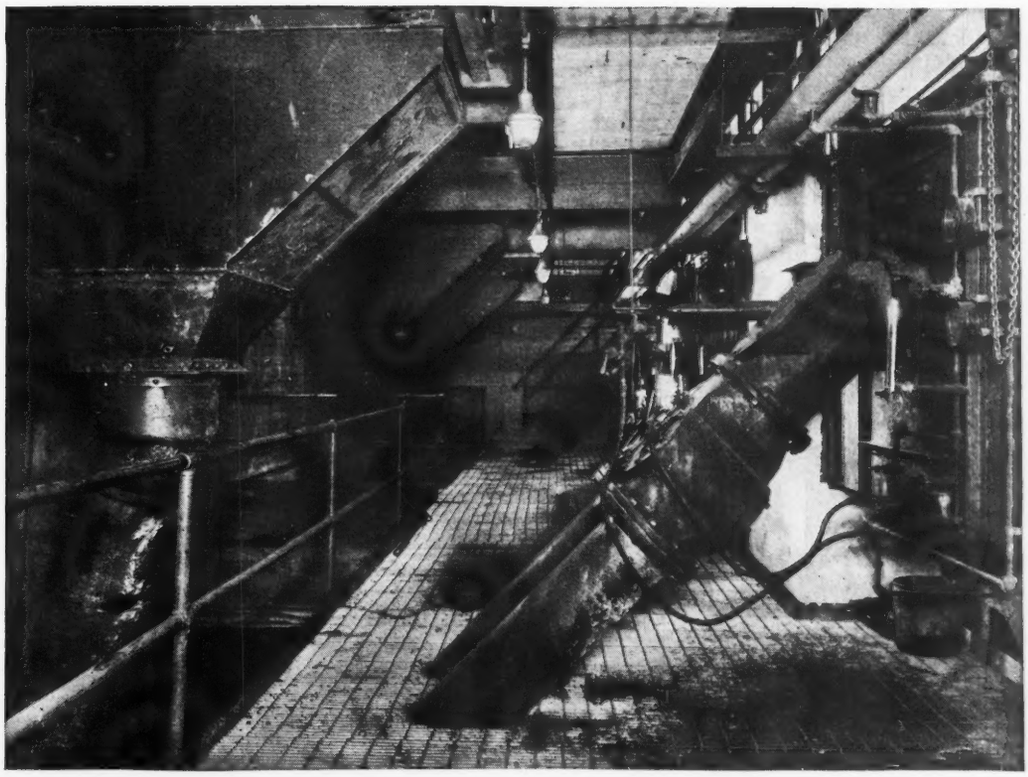
Harvard Medical School is in Boston, Mass., some three miles from the main group of the university buildings in Cambridge. The buildings of the Medical School, Dental School and School of Public Health are surrounded by those of the following institutions: Peter Bent Brigham Hospital, Children's Hospital, Huntington Memorial Cancer Hospital, House of the Good Samaritan, Boston Lying-In Hospital, Boston Floating Hospital (Land Division), Angell Memorial Hospital for Animals, and Carnegie Nutrition Laboratory.

All these, together with the Doctors' Co-operative Building, and the near-by Massachusetts School of Art, are served by the Medical School power house. A system of tunnels connects most of the groups with the power house; trenches tie in the outlying buildings, over 2,000 ft. away. The buildings served now total a volume of 27 million cubic feet.

Variety of Services Supplied

The plant supplies a variety of services, as follows: service steam (100 lb. pressure), steam heat, hot-water heat, domestic hot water, electrical energy for light and power (110-220 volt continuous current), low-tension current (24-volt alternating current) for annunciator systems, cold brine for refrigeration, and compressed air. There is even a vacuum service obtained from the heating return mains.

The first section of the old plant, placed in service in June, 1905, contained three 3,000-sq.ft. Stirling boilers with flat grates, hand-fired. Two years later another boiler was added. In 1913 four more units of the same size were installed, filling the present house, and Murphy stokers were installed under all boilers. The eight boilers of the old plant are set in batteries of two, in two rows facing a central firing aisle and parallel to the engine room. In 1920 oil-burning equipment was installed, and in 1927 two of the newer boilers were arranged for powdered-coal to obtain greater output.



Boilers are fired with pulverized coal

The electrical generating equipment of the old plant consisted of two 300-kw. corliss-engine-driven units and one 125-kw. Ball engine-driven generator. To these was added, in 1926, a 600-kw. vertical four-cylinder uniflow engine. Since the plant has no connection to an outside power source and because uninterrupted service is imperative, adequate spare capacity is necessary.

The growth of the load went on, and continually reduced the spare capacity in the plant. It is difficult, of course, to predict the future expansion of a group of institutions like this one, but a growth curve of the connected-building volume shows a very definite trend over the twenty-five years since the group was started. Based on this trend and upon the ground area available for expansion of the institutions, an ultimate plant size was arrived at.

The arrangement of the old boiler house, its low height and narrow width, precluded any possibility of installing a modern type of boiler unit therein. Furthermore, it was desired to utilize the two small powdered-coal fired boilers some time longer as spares. The new boiler house was therefore built adjacent to the old, and as new units are added the old house will give way to the extension.

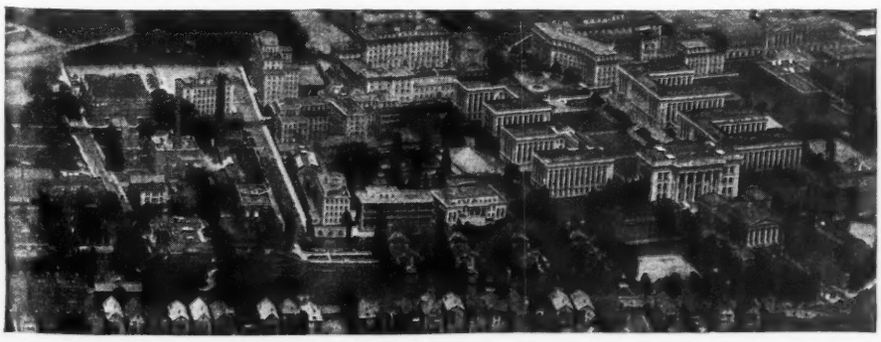
Since in this locality heat energy in the form of coal costs about two-thirds that in the form of oil, the new extension is designed for burning coal in powdered form. The old oil-fuel equipment will, however, remain intact and will be available for starting and for emergency use.

Two New Boilers

The two new boiler units each consist of 6,154-sq.ft. Stirling Class 21 boilers with 6,126-sq.ft. tubular air heaters and Bailey water-cooled furnaces. The furnace is hoppered front to back. The downtake, or rear wall, is covered with 148 sq.ft. of block. The side walls have 675 sq.ft. of block, and the front wall above the burned 393 sq.ft. of cooled surface, made up partly of bare tube and tile and partly of cast-iron blocks. The furnace volume is 4,380 cubic feet.

Although the boiler was specified for a maximum steam output of 75,000 lb. per hour, the auxiliaries and the gas passages are proportioned so that 100,000 lb. per hour may be obtained. Operating experience to date indicates that the unit will operate successfully at the higher rating. At 75,000 lb. per hour the heat liberation is 22,600 B.t.u. per cubic foot; at 100,000 lb. it is 30,000 B.t.u.

Low-pressure steam is required for hot-water heating, for service hot water and other purposes. The aux-



Harvard Medical and allied buildings are served by a central plant

iliaries—boiler-feed pumps, coal mills, blast fans and stack fans—are therefore steam-turbine-driven, one feed pump and the middle coal mill being electrically driven to provide flexibility in obtaining heat balance.

The old boilers and steam-using equipment are designed for saturated steam at 125 lb. operating pressure; the new boilers are built for 250 lb. pressure and 100 deg. superheat. Hagan pressure-reducing and desuperheating apparatus is provided to condition the steam for the old equipment and for the steam lines to the buildings. The new boiler auxiliary turbines, the turbine-generator and the uniflow engine set take the steam as produced by the new boilers.

Pocahontas slack is the economical fuel for this plant. Being low in ash, this coal minimizes the ash-handling problem. The coal is fed through Richardson scales to turbine-driven Riley mills and fired through single burners. An electrically driven mill is located between the other two, and its discharge is so connected that it may feed either boiler. The mills are equipped with separate feeder motors controlled by hand from the firing aisle.

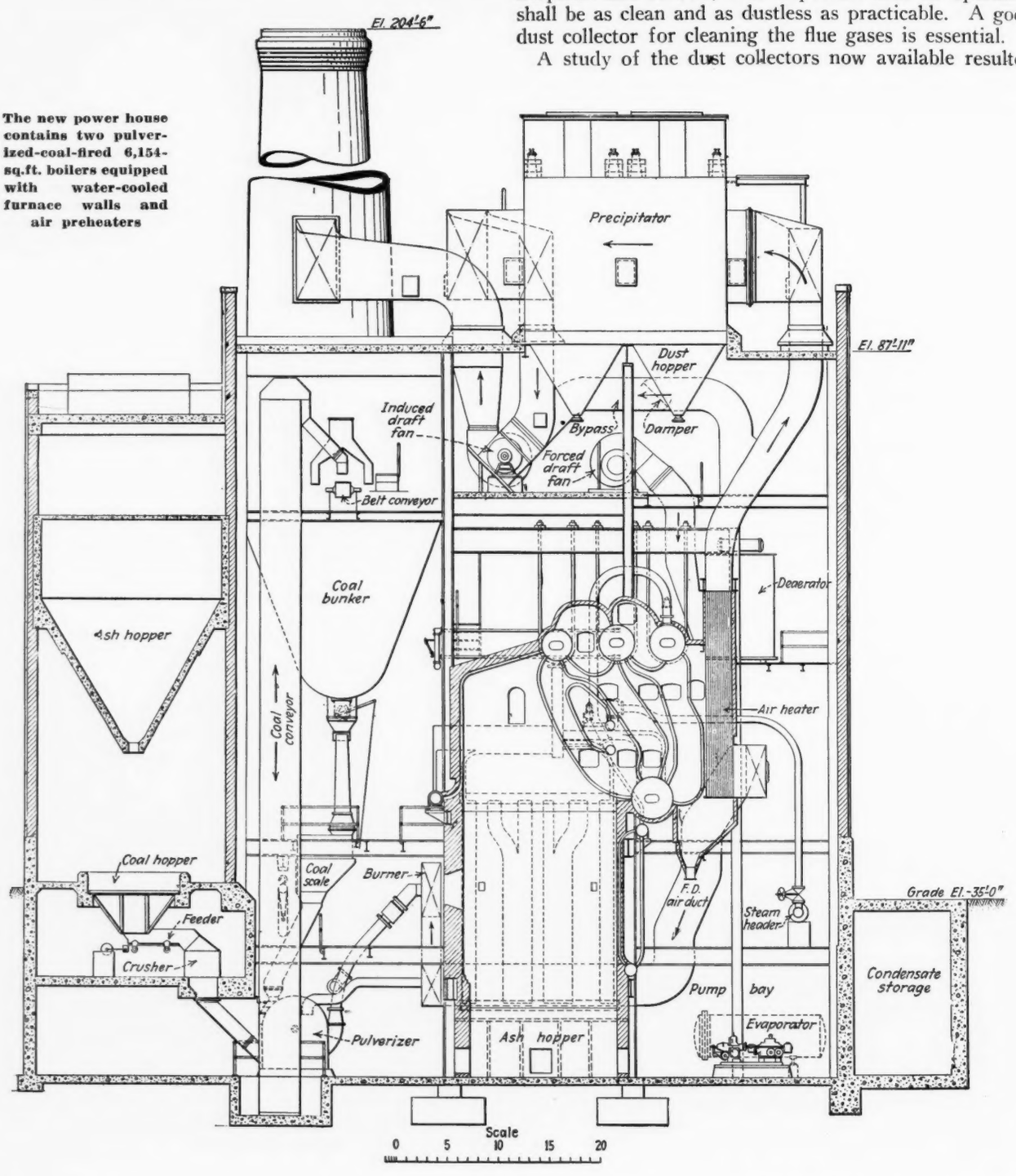
The induced-draft fans are also hand-controlled, from the control panels on the firing floor in front of the boilers. The forced-draft fans are controlled by the furnace pressure regulators. As the plant load will now be carried on one boiler during most of the year, the installation of automatic control has been deferred until the load increases and more boilers are added.

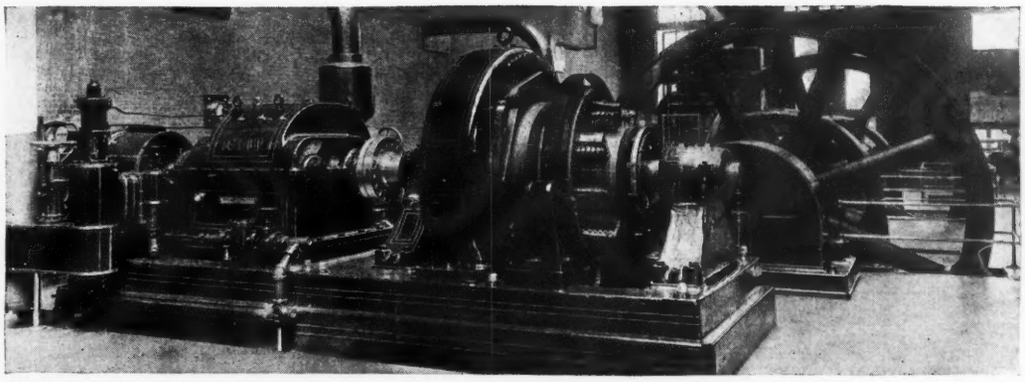
Electrostatic Precipitator Gives Excellent Results

Since the plant is situated in the midst of groups of hospitals and schools, it is important that its operation shall be as clean and as dustless as practicable. A good dust collector for cleaning the flue gases is essential.

A study of the dust collectors now available resulted

The new power house contains two pulverized-coal-fired 6,154-sq.ft. boilers equipped with water-cooled furnace walls and air preheaters





New 1,000-kw. geared turbine-generator exhausts at 1 lb. gage pressure

in the selection of the Cottrell electrostatic precipitator. This type of dust collector takes out more of the fines of the flue dust than the mechanical or the hydraulic types of separators will catch, and while energy is required to charge the electrodes this is more than offset by the lower draft loss through this precipitator.

By building a special double unit between the two boilers, having a single housing divided by a light wall, and also proportioning the unit to give its maximum efficiency at about two-thirds of maximum rating of the boilers, an installation was obtained which in cost compares favorably with other types of dust collectors, and which does a very acceptable job on the flue gases. The acceptance tests show the units to be well within the guarantees. This performance will not be appreciably lowered at the maximum boiler rating of 100,000 lb. per hour. The precipitators are located ahead of the stack fans; thus the gases are cleaned before they reach the fans with the result that blade erosion is practically prevented.

Roughly, 90 per cent of the condensate is returned to the plant. An evaporator with a capacity of 10,000 lb. per hour is installed for the make-up. Water for boiler feed and other plant purposes is purchased from the city, the old deepwells at the plant having become practically exhausted. It is essential that economy in the use of water be practiced to keep down costs. Oily condensate is treated with alum and soda ash and is then filtered. All of the boiler-feed water is sent through a deaërating heater.

To meet the growing electrical load, a 1,000-kw. De Laval geared turbine-generator operating against 1 lb. back pressure is installed on the foundation of the old 125-kw. Ball engine-generator. It is provided with a centrifugal oil purifying machine.

One of the features of the new addition is the welded piping. All of the pipe joints, except at valves and steam-using equipment, are welded. This eliminates a great deal of joint trouble and adds greatly to the neat appearance of the plant.

All of the floors, except the fan deck, are of subway grating, giving a light and well ventilated house. The air for combustion will be drawn through a monitor on the roof.

The design work for the new boiler plant was carried out by L. E. Chadbourne of the office of Densmore, LeClear & Robbins, under the direction of W. S. Burke, inspector of grounds and buildings, A. R. Kenny, chief engineer of the Medical School power plant; and the writer.

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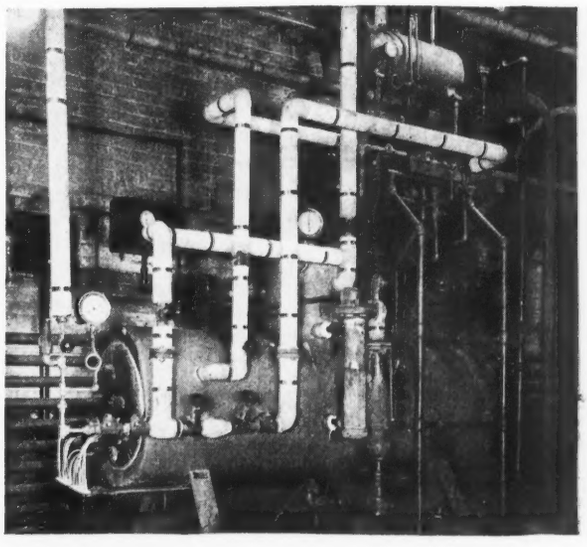
Application of Steam Generator In Research Laboratory

An interesting application of the electric steam generator is shown in the Figure. The research department of a large corporation was faced with the necessity of obtaining steam at 200 lb. pressure for use in an atmosphere which might become explosive. The General Electric Company suggested the use of an electric steam generator, pointing out that this installation would save the cost of a new building which otherwise would have had to be built remote from the laboratory if a fuel-fire was to be used safely. The use of the electric steam generators made a licensed engineer unnecessary.

Accessory equipment includes an automatic pressure governor, an automatic heat shutoff and a low-water alarm whistle. Great care was taken in the design of the equipment to minimize danger in its operation. For example, the magnetic switch operates in oil, the pressure governor is inclosed in a gas-tight case, and the automatic heat shutoff switch operates inside of the generator under 200 lb. pressure.



Electric steam generator rated at 120 kw. used where atmosphere might become explosive

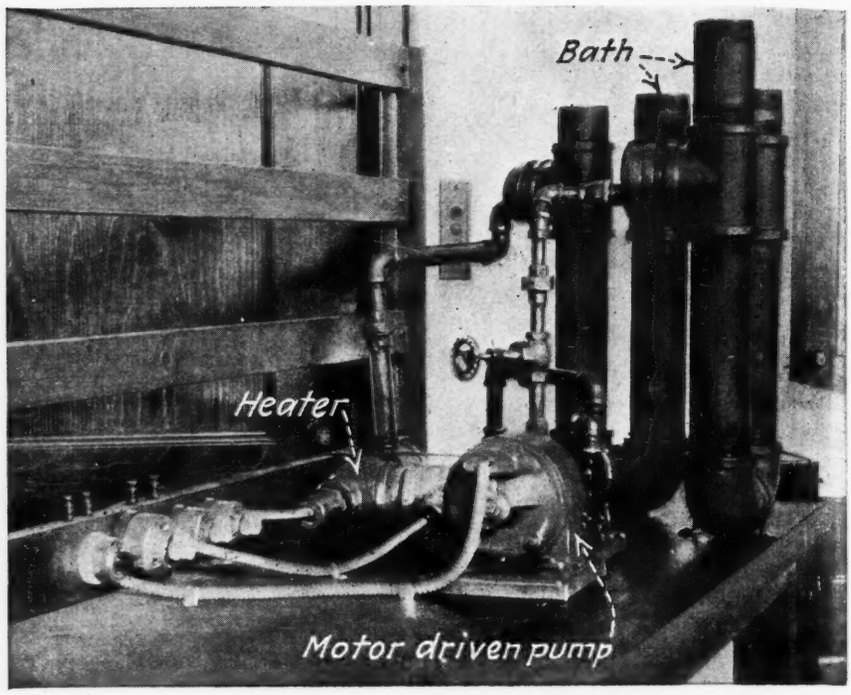


Fig. 1 — The entire outfit contains nothing except motor, pump, valve, heating elements and pipe fittings

By J. R. CONNELLY
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A PRACTICAL OUTFIT FOR Thermometer Calibration

Instructions for assembly of a thermometer calibration outfit that will function without trouble and with a high degree of accuracy

A THERMOMETER or other temperature-measuring instrument may have an illuminated scale, a nicely finished protector and a fancy name and at the same time be the greatest deceiver in a plant. An erring thermometer is often worse than no thermometer at all, because it gives a false sense of security.

The one way to be sure of the accuracy of temperature instruments is to test them in comparison with instruments of known correctness. If reasonable accuracy is desired the various temperature devices should be tested at frequent intervals.

Two or three good mercury-in-glass thermometers with Bureau of Standards certificates and some type of bath form a simple outfit which if carefully used will yield satisfactory results for most industrial uses. Occasionally the standard thermometers should themselves be returned for checking.

The bath here described was constructed in the mechanical engineering laboratory at Lehigh university as one unit of a project which when completed will be able to calibrate temperature instruments through a total range from approximately minus 20 deg. F. to 2,000 degrees.

In designing the bath three characteristics of prime importance were kept in mind. First, the bath must have sufficient volume so that radiation loss cannot produce rapid changes in temperature, making "snap" readings necessary. Second, circulation should be sufficient to keep all parts of the instrument at the same temperature. Third, the bath should be large enough to permit of complete immersion of the sensitive elements of instruments, especially the large thermocouples used to measure flue-gas temperatures and similar instruments.

The unit consists of the bath proper, the heater and the circulating device. The layout is illustrated diagrammatically in Fig. 2, showing the flow of oil as it passes from the heater to the pump and then to the bath proper and back to the heater. Heating is accomplished by two electrical resistance heaters projecting into the oil stream. Circulation is produced by a small centrifugal pump driven by a splashproof motor. The oil is forced to circulate up and down the various risers, in which are suspended the instruments being tested.

The heater was placed on the suction side of the centrifugal pump after it was found that the preliminary

"warming-up" period could thus be materially decreased.

A heavy mineral oil was used in the bath because of its high flash point and low volatility at elevated temperatures. This oil does not flow freely at temperatures below 90 deg. F., so the heater must first be turned on to warm the oil up to that temperature before the motor can operate the pump at any useful speed.

The particular oil used had a flash point well over 500 deg. F., so if an operator did not desire to calibrate up to that temperature a lighter mineral oil could be used in the bath and the pump started without any delay.

A globe valve was placed in the discharge line of the pump to throttle the discharge partly at higher temperatures and thus avoid overloading of the motor.

Various Connections Alter Temperature

Each unit heater consists of two elements separately connected to a special three-heat switch by which the elements may be operated in series, or separately or in

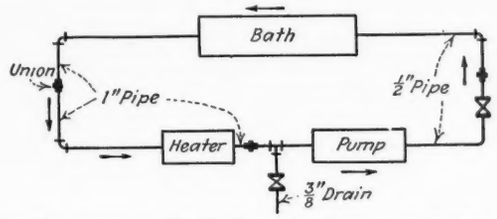


Fig. 2—For more rapid starting with heavy oil the heater is placed on the suction side of pump

parallel, thus giving quite a variation in rate of energy supply.

Fig. 3 shows an assembly sketch for the various components. The bath proper and the heater unit are assembled separately. In all the pipe work it is well to keep in mind that hot oil is the fluid in the pipes and only first-class pipe fitting will be satisfactory. To insure oil tightness it is suggested that all joints be painted with a paste of "Smooth-On" or shellac before assembling.

In assembling the heater unit care should be exercised that construction is such that the resistance elements shall always be totally submerged in the oil, that the elements do not make contact with the surrounding fittings and that they are in the center of the oil stream.

Provision for Oil Expansion

The bath proper required some means of allowing for the expansion of the oil as it became heated. The pipe caps at each end of the bath were drilled for the one-inch connecting pipe as low as possible on the pipe cap, and in addition short nipples were screwed into the tops of the various risers, the one nearest the inlet being the longest. This arrangement proved adequate for the expansion of the oil and also for the differential head between the various risers.

Bill of Material

1 G.E. switch Catalog 278610.
2 G.E. switch Catalog 278607.
2 G.E. Helicoil water immersion heaters Catalog 15x829, 220 volt, 2,000 watt, three heat.
1 1/12 hp. Westinghouse single-phase splashproof motor.
1 ½-in. Gould centrifugal pump No. 150629.
1 5-gal. can of extra Hecla mineral oil.
3-in. pipe fittings.
6 Close nipples.
3 Nipples 3½ in. long.
2 Nipples 4 in. long.
1 Nipple 6 in. long.
4 Nipples 14 in. long.
6 Tees (3x3x3).
2 Pipe caps.
2 Pipe plugs.
2 90-deg. elbows with threaded opening for 1½-in. pipe opposite one of the 3-in. openings.

After each unit was properly assembled the entire apparatus was joined, using a union between each unit and its neighbor so that the whole could be emptied and cleaned, if necessary, in a short time. The connecting lines were provided with drains for the same purpose.

The entire set-up of this equipment has been rigidly installed on one of the standard laboratory movable tables so that if an instrument cannot be brought to the calibration, or the instrument is to be calibrated in place, the whole apparatus is taken to the instrument and set up wherever 110-volt alternating current or 220-volt alternating current or direct current is available.

How to Operate

To operate the bath after the preliminary warming-up period the current is turned on to a rather high value until the oil reaches about the temperature desired, then reduced until it is just sufficient to make up the loss by radiation with the pump operating.

After the temperature has remained constant for from five to ten minutes, depending on the size of the device to be calibrated, readings are taken on both the standard thermometer and the unknown instrument. The current is then turned on to a high value until another desired point is reached and the process repeated as before.

As many points may be taken as the operator desires up to the limit of the fluid in the bath. It is advisable to take another set of readings during the cooling of the bath. To accomplish this run the pump with the heaters shut off until the bath has cooled to the desired point. Then turn on the heaters just enough to keep the temperature constant for a short time before a reading is taken.

It is believed that one advantage of this oil bath is its ability to accommodate a number of instruments at one time. While it takes some time to run a complete calibration, several instruments may be calibrated on one run, thus reducing the operator's time per instrument. During the period of reading the temperature drop through the bath proper is a small fraction of a degree Fahrenheit without insulation. With the addition of, say, a ½-in. layer of hair felt, the temperature drop is so small that, for many purposes, standard thermometers at the inlet and outlet of the bath proper are sufficient.

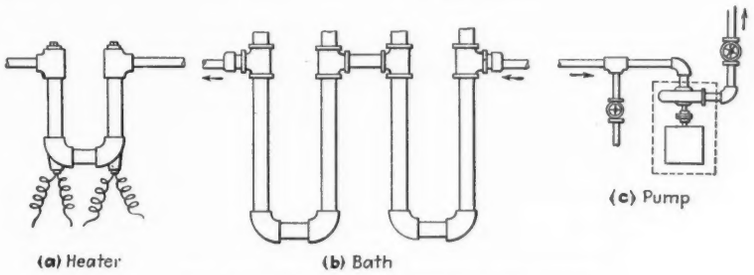


Fig. 3—The three elements of the outfit

Compound Compressors For Refrigerating Plants

Some of the reasons for the increasing use of compound compressors in refrigerating plants; and design features of German compressors of this type

By HANS FREUND
Tegel, Germany

THE decision as to whether a single-stage or a compound compressor would be more suitable for a refrigerating plant was formerly based on the ratio of the pressure in the evaporator and that in the condenser. Today, however, a number of other factors should be taken into consideration.

The limit of the pressure ratio referred to used to be about 1 to 6 and, whenever this ratio was exceeded a compound compressor was chosen, because cylinder measurements would be abnormally large due to the considerable decrease of volumetric efficiency, and the final temperatures would be much too high if single-stage compression were used. The disadvantage resulting from an inferior volumetric efficiency was at first counteracted by designing the clearance spaces abnormally small. Up to a certain extent this remedy proved successful, but it is of no use whatever at present, when such high pressure ratios as 1 to 30 or 1 to 40 are concerned.

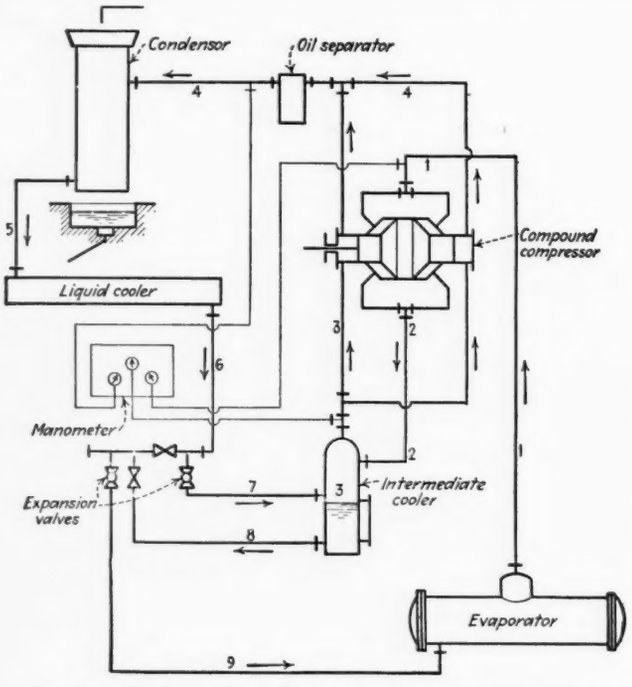


Fig. 1—Diagram of a refrigerating plant with compound compressor and two stage expansion

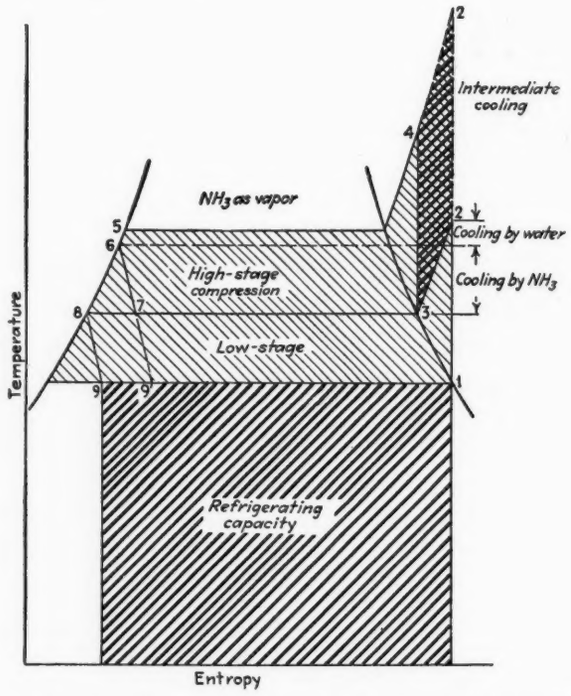


Fig. 2—Temperature entropy diagram of compound compression and two-stage expansion refrigerating cycle

The high final temperatures necessitated the use of metal stuffing boxes, which were already introduced at the time of resorting to the superheating method. Special brands of oil had to be selected for lubrication. These, although possessing a low solidifying point, were required to retain in full their lubricating properties at higher temperatures.

The introduction of the method of superheating resulted in a considerable saving of power, due to the increase in thermal efficiency. Additional economy, however, could be obtained only by increasing the mechanical efficiency, an object which was also nearly attained.

For a time the tendency, therefore, was to continue the use of the single-stage compressor, as the advantages obtainable from that of compound compression were not adequately realized. Advance of technical science—and more particularly that of technical chemistry—raised a growing demand for compressors with large differences in compression, by reason of the introduction of very low temperatures. It thus become imperative to tackle the problem of compound compressors more seriously, both as regards the theoretical and the practical aspects. One firm which at an early date recognized the advantages and possibilities of compound compressors was A. Borsig, which has made their manufacture a specialty.

Although the factors which gave original impetus to construction of compound compressors were the inferior

efficiency of single-stage compressors and the excessively high temperatures connected with their use, the compound compressor was soon found to possess, even for standard pressure ratios of about 1 to 4.5 so great an advantage with respect to power economy, that it became just as important in connection with the choice of a compressor as the high-pressure ratio had been at first.

In a compound-compressor plant such as indicated in Fig. 1 the vapors formed in the evaporator are drawn in by the low-pressure cylinder and delivered to a special intermediate tank at intermediate pressure. The resulting heat, in so far as the higher temperatures are concerned, is partly removed by cooling water, while subsequent cooling down to saturation temperature is most easily effected by injecting liquid ammonia into the intermediate tank.

The ammonia necessary for cooling is withdrawn at the adjusting station from the normal circulation, that is, from the condenser pressure, and is reduced to intermediate pressure. This withdrawal, it is true, represents a slight loss, inasmuch as the quantity used for injection must be subsequently recompressed without having absorbed any heat in the evaporator. However, this small loss is more than compensated for by the advantage gained by recooling the gases compressed in the low-pressure cylinder. Besides, the method described avoids the presence of excessively high temperatures.

From the intermediate cooler the vapors are drawn in by the high-pressure cylinder and then forced into the condenser, where condensation takes place under the influence of cooling water, just as is the case in every single-phase plant. The liquid is then cooled below the point of liquefaction in the liquid cooler and conveyed to the adjusting station, whence it is again caused to pass on to the evaporator.

Another improvement incidental to compound operation is the gradual pressure release of the liquid in stages, an advantage that is often underestimated. A pound of ammonia, no matter whether its condensation from condenser to evaporator pressure takes place in one, two or many stages, must always produce the same refrigerating effect. On the other hand, it must be remembered that when, for instance, two-stage compression is used we are at liberty to reduce the liquid first to intermediate pressure, so that the resulting vapors can be drawn in by the high-pressure cylinder direct, without passing through the low-pressure cylinder en route. Compared with single-stage expansion, this leads to a saving of power, inasmuch as the vapor generated in the intermediate stage can be conveyed to the condenser by way of the high-pressure part of the compressor direct, without passing through the evaporator. Since refrigerating effect can only be produced from liquid ammonia by its evaporation, the temporary withdrawal of the vapors in the intermediate stage is equivalent to relieving the evaporator.

It is advisable to combine this improvement with the intermediate injection already referred to, and so expand the whole amount of the liquid in the intermediate cooler to intermediate pressure. There the gases compressed in the low-pressure part enter at the same time, to be recooled by the evaporation of a certain portion of the liquid ammonia.

The position of the valves at the regulating station indicate that it is also possible, with a view to quick starting, to effect injection of ammonia directly into the evaporator.

The process just described can also be very conveniently studied from the temperature-entropy diagram, Fig. 2, which at the same time gives a clear presentation of the thermal conditions. The figures in the two diagrams indicate the same condition of the ammonia as regards its pressure and temperature.

A glance at the entropy diagram shows the area hatched with heavy lines represent the refrigerating effect, whereas the area hatched with light lines in the opposite direction indicate the power requirements. The hatched and counterhatched area shows the saving of power by using compound instead of single-stage compression.

Another material advantage of expanding the liquid by way of several stages is also made apparent in the diagram. The quantity of vapor mixed with the liquid as it enters the evaporator is small. Hence the heat-exchange surfaces of the evaporator are far more efficiently used than they would be if the exchange of heat were obstructed by excessive quantities of vapor.

With single-stage expansion about 20 per cent of the

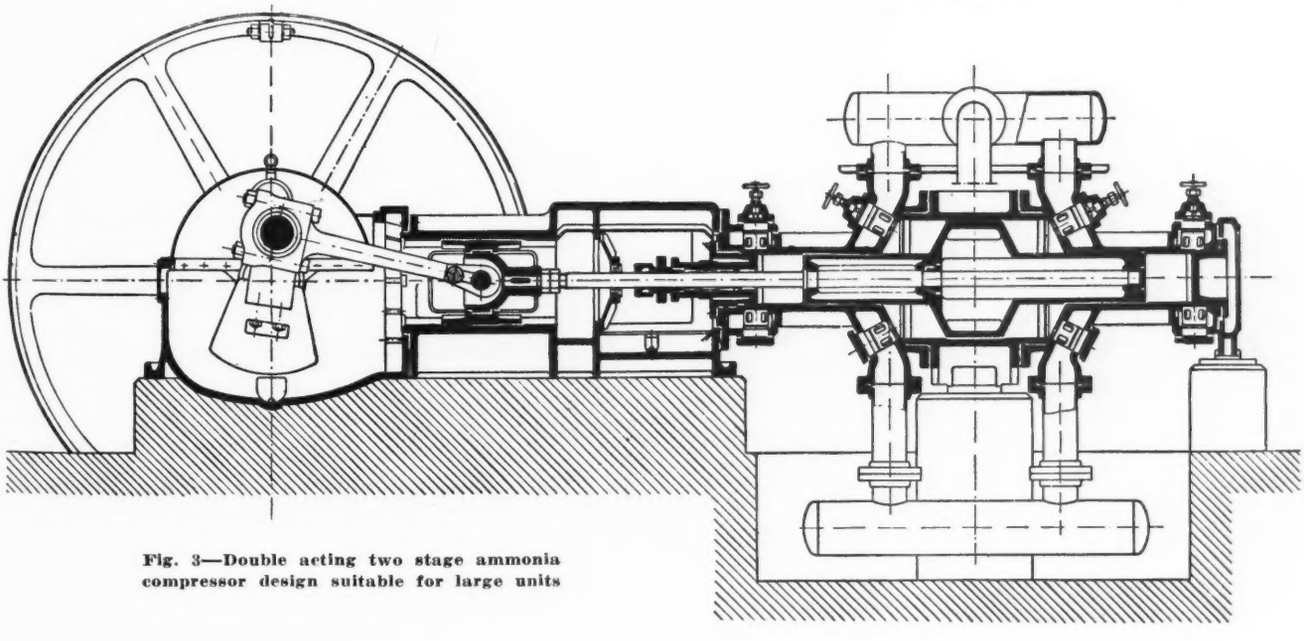


Fig. 3—Double acting two stage ammonia compressor design suitable for large units

circulating ammonia is converted into vapor by lowering the temperature from 95 to —4 deg. Added to this, there is the considerable diminution of the compressor efficiency during single-stage compression, so that the geometric cylinder volume of this compressor is probably some 50 per cent greater than that of the low-pressure part of a compound compressor.

The advantage of compound compressors, moreover, is particularly conspicuous whenever, in addition to the normal refrigerating effect at a low temperature, a supplementary effect at a medium temperature is desired or found beneficial. This applies, for instance, to cold-storage and refrigerating rooms in which large outputs are wanted at low temperatures, as well as at medium temperatures.

Compound Compressor Design

The principal structural elements of compound compressors, such as the bed frame, the cylinders, the whole of the driving gear (including lubrication, the flywheel and the outer bearings), may be taken over from the constructions of single-stage compressors, the corresponding part of which has been adopted to a large extent, not only with a view to uniformity of outward design, but also with an eye to the saving of time and money.

Although, in theory, every alteration of the condensation or evaporation temperatures results in a dislocation of cylinder conditions, so that the possible number of combination of high- and low-pressure cylinders is indefinite, it has nevertheless become possible to standardize compound compressors.

The double-acting method of operation has also been taken over from the single-stage compressor, the low-pressure cylinder being arranged in the center and the high-pressure part, divided between two cylinders, adjoining the two ends of the low-pressure cylinder. With this arrangement operation of the compressor is most stable, because the piston pressure remains the same irrespective of the direction of the stroke, even when the condensation and evaporation temperatures are fluctuating and thus leading to fluctuating power requirements.

An additional advantage is that the rear high-pressure cylinder can be removed without much difficulty when the piston rings are to be exchanged. The piston is thereby loosened in the crosshead, so that it can be withdrawn easily.

Fig. 3 illustrates an oblique design of the low-pressure cylinder which recalls, in a way, the ball-like shape of cylinder covers formerly in use. The idea underlying this design is to reduce the size of the clearance space, especially in the low-pressure part, as much as possible without incurring the disadvantage resulting from the difficult dismounting of the older types.

The suction valves are fitted with a screwing-down device, enabling the engine to be started without load and to reduce the output as desired. Placing the operating valves along the periphery of the cylinder makes it possible to increase the number of valves, thus enlarging the sectional area of flow while but slightly raising the cones or plates.

Whereas the compound compressor described above has been found excellent for large units, preference is given to the single-acting method of operation, as in Fig. 4, when small outputs are required, this being done for constructional reasons. Here, too, the size of the piston surfaces is such that the distribution of power remains the same irrespective of the direction of the stroke. Slight fluctuations caused by variations in the condenser pressure might, theoretically, result in a lack of uniformity, but as the compressor always operates at a higher speed this does not involve any practical difficulties.

The space between high- and low-pressure part formed by the back part of the low-pressure piston communicates with the intermediate tank, so that part of the cylinder is always under intermediate pressure. In this way the difference in pressure, both as regards the high- and low-pressure side, is reduced to the desired minimum. The special advantages of this single-acting type are that the cylinders and pistons for the high- and low-pressure parts can each be constructed of one piece. The differential piston can be taken out as easily as in any single-stage compressor of standard type.

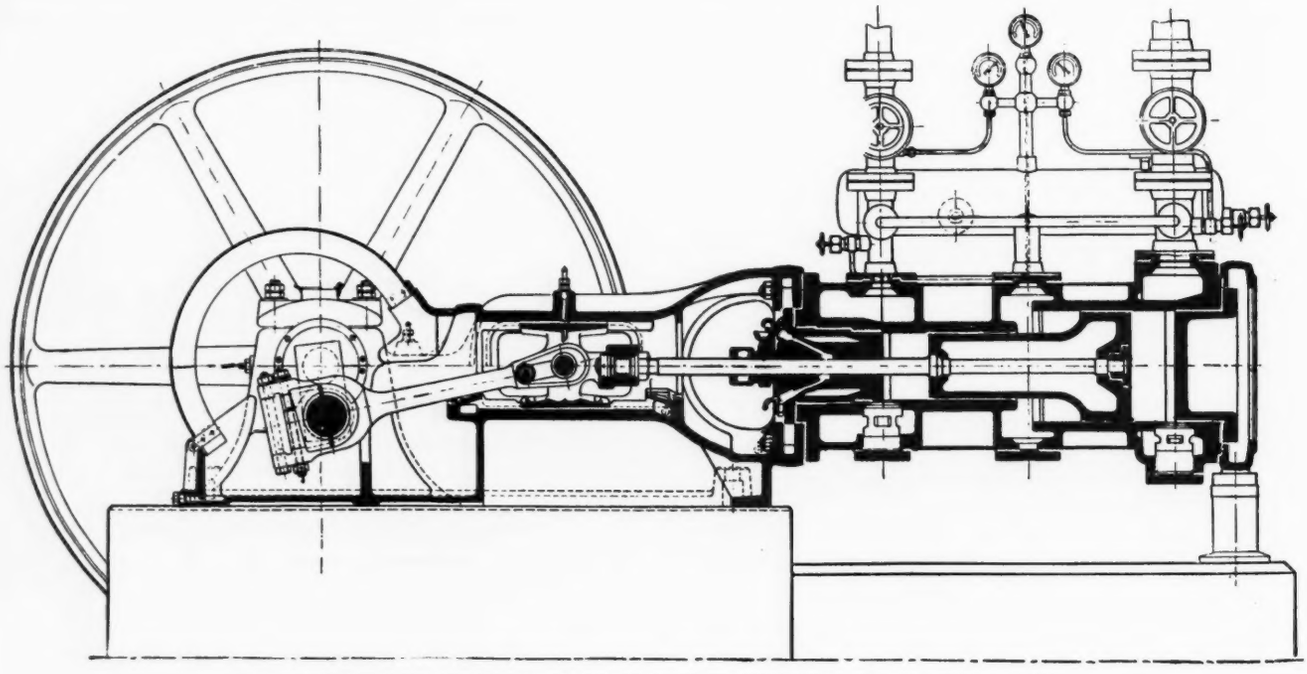
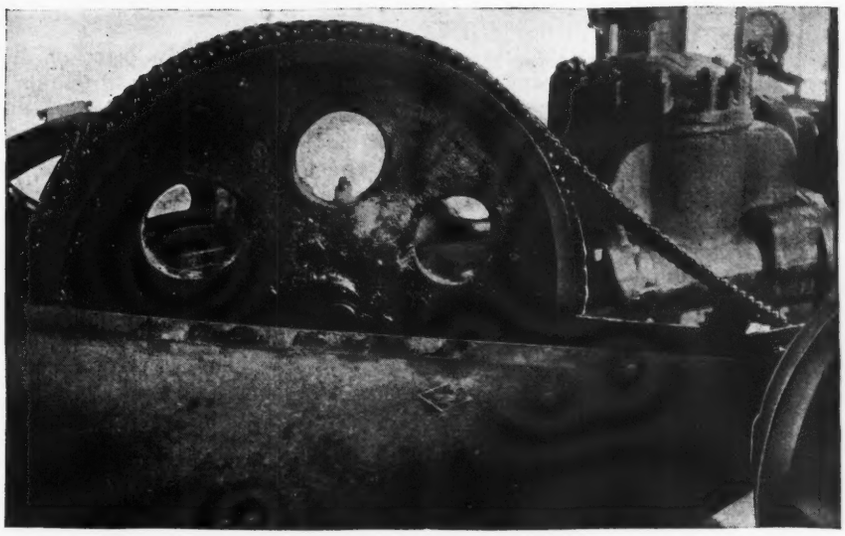


Fig. 4—Single acting compound ammonia compressor designed for smaller units



Quadruple roller-chain drive connects 30-hp. 870-r.p.m. motor to a duplex plunger pump

Lubrication and Maintenance of Roller-Chain Drives

Suggestions for the installation, care and lubrication of roller-chain drives, that, if applied, will insure high-grade service and long life of the chains and sprockets and low operating costs

By W. A. WARRICK*

ROLLER CHAINS are intended for severe service. Their case-hardened bearings are designed to resist wear, and the links which connect them have more than sufficient strength to stand shock overloads. Even though the manufacturers do their best to build chains and sprockets capable of trouble-free service, the users must contribute proper installation, lubrication and maintenance to obtain good service. Properly handled, roller-chain drives will give years of high-grade performance before chain replacement is needed, and sprockets will outlast two or three chains.

Shafts of chain drives must be level and parallel. This may be checked with a spirit level on each shaft, the distance between the shafts at two points being measured with a scale or tram. Sprockets should be well aligned, and if there is end float the alignment should be established for the running position, excessive float being controlled by proper adjustment of collars. With a straight edge against the sides of sprockets to be checked, there should be line contact. The alignment should be checked after both of the sprockets have been turned $\frac{1}{4}$ to $\frac{1}{3}$ revolution.

Idler sprockets should be checked in the same manner, and shoe idlers should be positioned to insure contact of the faces with the chain rollers only, not with the sideplates, as the latter will otherwise wear quite rapidly.

Sprockets must run true, that is, with little weave or wobble. Bent shafts, oversized bores or undersized shafts and tapered bores on straight shafts can cause this condition. Loose bearings should be taken up to prevent play in the drive and decrease impulsive chain loads.

Sprockets must be tight on the shafts and keys must be tight. Vibration and wear of keys and key seats permits of increasing looseness on the shafts and consequent misalignment is destructive to both chains and sprockets.

Before connecting links are inserted to make chains endless, the completeness of meshing should be examined, particularly for vertical-center drives. For these the mesh at the lower sprocket should be checked to avoid one or two dropped links. When chains are not too heavy to be handled readily, it is convenient to make connections with the terminal rollers about half way around the wrap of one sprocket, the teeth holding the chain ends in place and permitting the pin ends of connecting links to be inserted with little difficulty. In connecting multiple-strand chains, the full number of center-link plates must be used to make the connecting link strength equal to the remainder of the chain.

A length of light rope will aid in connecting the ends of heavy chains between the sprockets after the chain is in position on the wheels. One end of the rope should be fastened to a chain sideplate and the other rove back and forth between the ends to secure such multiplication of pull as may be necessary. The effect is that of block and tackle, the chain rollers functioning as sheaves. By this means the chain ends can be pulled into place easily and held in alignment with each other, and after the rope has been fastened the conecting link may be inserted by one person.

*Mechanical engineer, Diamond Chain & Manufacturing Co.

Coverplates for cottered connecting links should be driven in place evenly, care being taken that neither end gets much ahead of the other. Press fit of sideplates and chain pins being important, coverplates should not be re-used if avoidable. Cotters should be carefully spread. Loose cotters will shake and wear through at the spread, eventually dropping out. Connecting links of small chains should be carefully checked after the chain is in place. Spring-lock and spring-wire fasteners should fit home into the grooves in the chain pins.

For very high-speed drives, small chains should be riveted endless, connections being made with master links, which are not readily detachable. After coverplates have been tapped into place, the pin ends should be marked centrally with a blunt cold chisel, raising a slight burr at each end of the mark. No attempt should be made to reproduce the riveting or spinning of the ends of pins as done by the chain manufacturer, as this will bend the pins of multiple-strand chains, causing tight joints.

Adjustable sprocket centers should be set to provide approximately $\frac{1}{4}$ in. total movement of the slack strand of chain per foot of span, the measurement being made from one extreme position to the other. The best amount of slack for each installation should be determined by test to secure smoothest operation. If center distances are not adjustable, one offset link per chain should be used, when necessary, to prevent excess slack. Idlers should be positioned to insure good meshing without both strands being tight.

For drives with vertical centerline no special precautions are necessary, although adjustment for control of the slack at smaller total increments of chain length resulting from normal wear is advisable. Accumulation of slack that permits the chain to whip or snap is harmful, because this causes impulse loads. When center-distance adjustments are used up, the chain length should be decreased by as many pitches as can be removed with the adjustment in position for shortest center distance.

Drives with parallel multiple-strand chains should employ matched chains of identical length, the chains being installed with pin links in line with pin links and roller links in line with roller links.

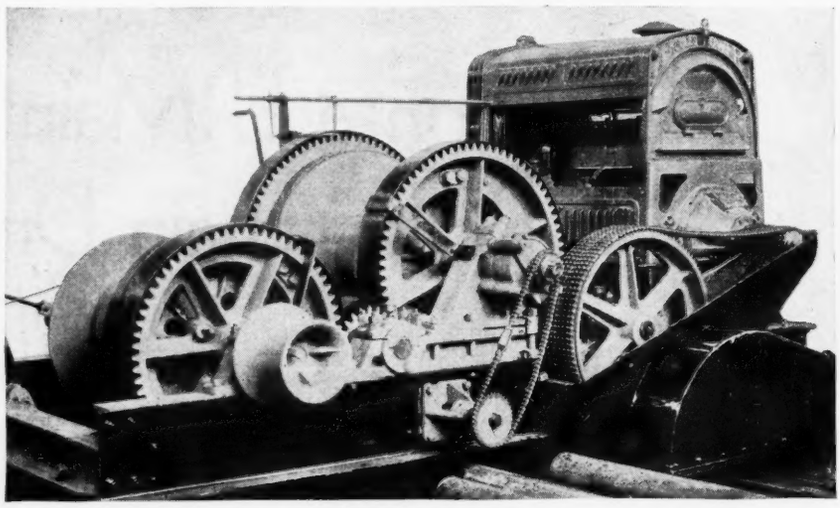
Commercial sprockets are usually not perfectly concentric. A little eccentricity is not harmful, especially for moderate shaft speeds, but large eccentricity is injurious. Eccentricity can be checked before sprockets are installed by calipering from bottom diameter between teeth to the bore at three or four points around the circumference. After sprockets are installed a rough check on concentricity may be made by pulling the slack strand of chain to an extreme position and then noting whether the chain pulls in or out as the sprockets are rotated slowly by hand.

When eccentric sprockets are installed with the high sides between the centers of rotation, and with the chain tight, a slight amount of rotation will subject both strands to severe loads as the sprockets turn toward the high points. Accordingly, chains should be installed with centers so adjusted that the slack strand is not under tension in any position of the sprockets.

Consistent attention to proper chain lubrication should begin before starting operation. All chains should be thoroughly lubricated in place on the sprockets before drives are run. Lack of attention to this detail can harm the chains permanently.

High-speed drives in continuous service should be completely inclosed in oil-retaining cases, the oil being circulated by pump, drip cup or slinger. High-speed chains will develop undesirably high temperatures if run submerged in oil, the quality of the oil will be deteriorated and it will be difficult to prevent leakage from the inclosure. At moderate speeds chains may either be run in oil or lubricated by the means previously mentioned.

In designing chain cases fairly substantial clearances should be allowed, to prevent the development of localized pressures due to windage. There is little tendency for leakage due to throwing of the oil from the chains, but oil which drips on the shafts tends to creep and must be restrained by glands, seals or wipers. Doors should be provided to facilitate inspection, and upper and lower halves of cases should be hinged. Drain cocks will encourage re-use of the oil when drip cups are used. Sight gages should be located to serve also as overflows for drives lubricated by drip cups, decreasing the possibility that delayed draining of the case may permit too high an oil level.



Paired triple-strand roller chains run in an oil bath and connect an 85-hp. gasoline engine to a hoist

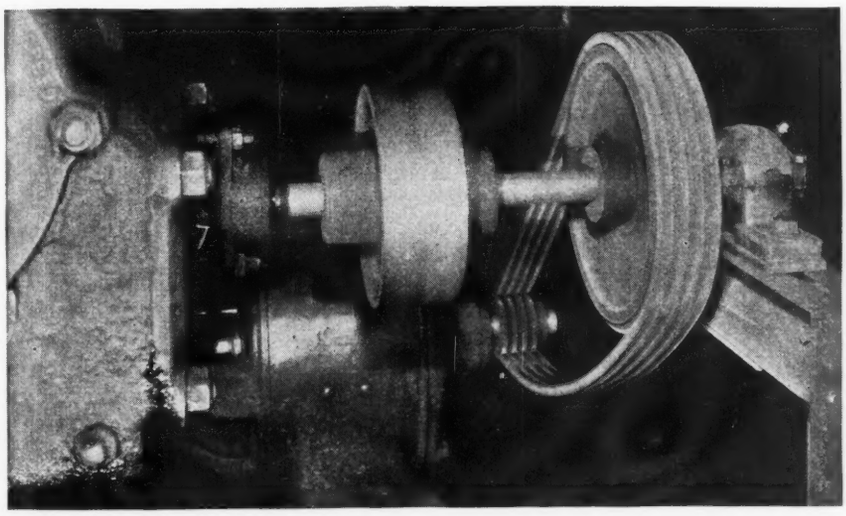
Manual lubrication at regular intervals will suffice for many drives run at moderate and low speeds, the frequency of application being controlled by the character of the service. High-speed drives, likewise, when not in continuous service, may be lubricated with a brush or squirt can, the oil being applied inside of the chain and preferably on the slack strand where the joints are relaxed. A sheet-metal band may be used when necessary to prevent throwing of the oil on to adjacent objects.

Chains not adequately lubricated develop a characteristic oxide in the joints which resembles rust in appearance. This is in evidence even after lubrication unless the chains have previously been cleaned thoroughly in gasoline or kerosene. External surfaces of the chain are not rusted in such instances, but the conclusion is drawn occasionally that the joints were rusted before the chain was run. Disasembling will show whether the rust has been occasioned by moisture or by overheating as a result of insufficient lubrication. The pins and bushings of well-lubricated chains, even when worn, are bright and

smoothly polished; but those of unlubricated chains run at high speeds are galled and grooved and of a light-brown color.

Clearances between the sideplates of roller chains are small, due to the accuracy of manufacture, and require fairly light-bodied oils to penetrate the small passages. These oils should be of good quality, the cost of lubrication being negligible, particularly for inclosed drives provided with means for recirculation. Replenishment is needed occasionally to maintain the proper oil level, but complete changes are unnecessary as a rule excepting at intervals of several months. Only a few drops per minute is necessary for drip-cup lubrication.

Certain greases made especially for chain lubrication



Roller chains when properly installed run smoothly as indicated by this 1,700- to 475-r.p.m. stroboscope-motor drive

have the property of penetrating the small clearances to the pin-bushing bearings, and are sufficiently adhesive to resist throwing excepting at high speeds. Heavy oils, such as cylinder stock, cup grease and hard grease, should not be used. These will quiet drives temporarily, creating the illusion that they are lubricated; but these lubricants seal the clearances and render ineffective subsequent lubrication with proper materials. Tallow, even applied hot, should not be used on chains, because the acid content will rust and corrode the finely finished bearing surfaces.

All chains should be removed and cleaned occasionally, frequency depending on conditions of operation. Before removing a chain both sprockets and the chain should be so marked that they can be replaced in exactly their original relation, to insure the running fit of the chain.

Chains exposed to sand or other abrasives should be removed and cleaned periodically, by dipping in gasoline or kerosene. The links should be worked back and forth, the chain being turned over occasionally, until all grit has been washed out. After thorough draining, the chains should be immersed in hot grease of good quality, allowed to remain until the temperature of the chain and the grease is equal, and the links should be worked to assure thorough penetration of the joints. After cooling, with the links pushed together to take up the play or back lash, excess grease should be wiped off. The outside surfaces may catch some grit, but this will do no harm, for there is no tendency for it to work into the pin-bushing bearings.

Chains exposed to abrasives will give much better service if lubricated as described than if not lubricated. When speeds are high, unlubricated chains become hot enough to draw the case-hardening of pins, bushings and rollers, thus materially shortening the service life. Chains which have been overheated can be identified by the change in color of the parts in comparison with new chain.

When chains are removed for cleaning and lubrication they should be checked for evenness of wear. All broken or cracked parts should be replaced at once with complete assemblies of connecting links or roller links. No attempt should be made to replace individual parts, such as rollers, bushings and pins, as this destroys the press fits. Salvage of this nature is false economy. Complete chains being relatively inexpensive in proportion to their responsibility, replacement of worn chains will be more economical in the long run than partial repair.

While running, chains should be inspected to see whether the rollers seat near the tops of the sprocket teeth, as this is an indication of worn-out chain. Replacement is advisable before the rollers actually slip over the tops of the teeth, which may cause breakage of sprocket teeth and of the chain.

A check of chain wear can be made without removing the chain, by pulling it away from the sprockets. If the chain can be slipped over the ends of the teeth, complete replacement is imperative, as continued use will harm the sprocket teeth and require sprocket replacement also. If the chain can be kinked one pitch is should be shortened as much as possible by removing links when the centers are adjusted to their closest position. The center distance should then be established for a correct amount of slack.

When misalignment has existed the inner surfaces of roller-link plates will show wear, usually acompanied by side wear of the sprocket teeth. If misalignment has existed for some time the sideplates may have worn seats into the sides of the teeth. If the sprockets have hook-shaped teeth, as the result of normal wear, they should be replaced, particularly if new chains are to be installed. The forces necessary to mesh new chains over the hooks will pull the chain apart.

Occasionally sprockets can be reversed if the hubs are symmetrical, or, if plates can be removed, by taking the sprocket off the shaft and turning it end for end to present correct tooth faces to the chain. Badly hooked teeth may be dressed in an emergency, but complete new sprockets should be installed if available. Spaces between sprocket teeth should be inspected to see that bottom diameters have not been increased by the presence of foreign material. Sometimes ropes and rags wind around sprocket hubs and build up high enough to prevent the chain rollers from seating properly, increasing the actual pitch of the teeth and requiring premature replacement.

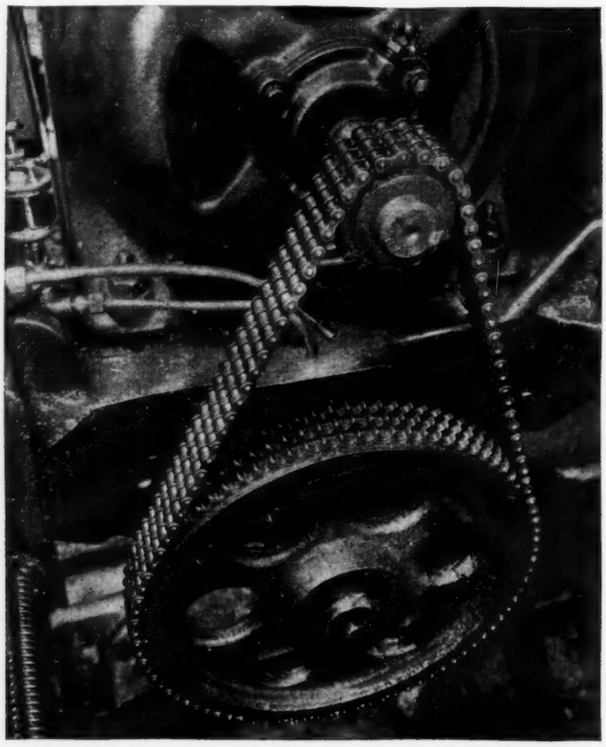
Sprocket alignment should be checked periodically to see that the wheels have not loosened, possibly permitting shafts to slide endwise. Machine bearings should be checked for excessive wear at the same time.

Accurate sprockets and standard chain parts should

be used for replacement service, but it should be expected that when new repair parts are installed with badly worn chains the differences in pitch will tend to cause some degree of unevenness and roughness of running.

When chains have broken, either as a result of having been continued in service after being worn out, or as the consequence of an accident, many of the parts have been stressed very nearly to the limit of their strength. Once a chain has broken, the mechanical value has been depreciated, particularly if the pins and bushings have been loosened in the sideplates.

The frequency of drive inspection should be governed by the character of performance desired and the severity of the service. Necessary repairs should be made promptly, terminating the destructive action on other parts of the drive. The short time required for such



This roller-chain drive runs in an inclined plane and is drip lubricated

work will save the expenditure of more time and more work at a later date.

In judging the performance of roller-chain drives, the conditions of service should be taken into account. When unusually small sprockets are used, the chain pins turn through greater angles, and bearing pressures in the chain are higher than if the wheels are larger. Short chains wear out more rapidly, because each part must accept proportionately more wear. Idlers which introduce reversed bends in the chain path tend to accelerate the rate of chain wear. Even identical drives will not establish identical records of service, because of variations in the operation, lubrication and quality of maintenance.

When the performance of roller-chain drives leaves something to be desired, the basic cause should be determined, and conditions of usage and maintenance should be examined, instead of drawing conclusions from surface indications. If chains seem to wear too rapidly, the correctness of installation and lubrication should be checked. When a chain breaks, its length should be measured to determine whether pitch elongation as a result of normal wear was sufficient to permit sliding over the tops of the teeth. The chain rollers should be inspected for dents, showing interference with the tooth ends. See if the latter are rounded or broken as a result of abnormal meshing. Cut and deformed teeth establish a presumption of previous breakage, which will be substantiated by twisted chain links.

Abnormal rates of sprocket wear, other than from lack of lubrication, ordinarily result only from misalignment and improper meshing due to interference or continued use of worn chain. Instances of the first two causes are less frequently encountered than the last mentioned, but all are relatively rare.

Incorrect selection of chains and sprockets is the most frequent cause for the existence of noise, although it should be expected that worn chains and sprockets will not be as quiet as they originally were. Wearing of cotter pins sometimes occasions unnecessary concern when it is not realized that cottered chains are held together by heavy press fits. The cotter pins are an inheritance from the time before the accuracy of modern manufacture was achieved. Most chains will run just as well without cotter pins as with them; but when it is necessary to re-use coverplates for connecting links because new ones are not available the decreased press fit should be offset by careful cottering, with the cotter pin ends well spread.

Rubbing contact of the edges of chain sideplates is occasionally a cause of chain trouble, due to interference with fixed elements, such as machine frames or beams. The chain sideplates, not being intended to resist wear of this nature, will be weakened as their cross-sections are decreased and stiff joints will be caused by burrs at the sideplate edges. Improper meshing is more frequently due to stiff joints than to chain breakage, because normal working loads are only a small proportion of the strength of the chain.

Prevention of rust is the most important factor in avoiding chain and sprocket deterioration of drives for seasonal service when not in use. Chains exposed to the weather should be removed, thoroughly cleaned in gasoline and slushed with heavy grease. The sprockets, also, should be slushed. When again placed in service the protecting grease should be cleaned off and the chain lubricated with oil.

When chains rust, pins and bushings freeze together. Subsequent running may loosen these joints, but frequently relative movement between pins and bushings is impossible and either the pins or the bushings will loosen and turn in the sideplates, causing wear in the sideplate hole and rapid elongation.

Rusted chains can sometimes be loosened by soaking in kerosene or by using special preparations for freeing rusted joints. New parts should be put at all joints that cannot be limbered properly. All pins and bushings loosened by running after rusting should be replaced with complete new links. After the removal of rust, chains should be thoroughly cleaned and lubricated. Corrosion of the internal surfaces shortens the chain life, although good service may be possible for some time if the joints have been correctly limbered.

Unusual circumstances which may account for an unsatisfactory performance of roller-chain drives may be analyzed without difficulty if their general principles are understood, making subsequent correction and repair easy. The resistance of roller-chain-drive to severe operating conditions is such that they rarely give trouble if properly selected and well lubricated.

Maintaining Equipment in Hydro-Electric Plants

By J. ELMER HOUSLEY
Superintendent
Tallassee Power Company

Inspection and maintenance methods that have proved successful and are the outgrowth of eleven years' experience on a system that has increased in size to where there is now nearly 300,000 hp. installed capacity

Report No. _____ Date _____

INSPECTION REPORT
OIL CIRCUIT BREAKERS

Location _____ Switch No. _____
Make _____ Type _____
Volts _____ Amps. _____
Inspected By _____ Date Last Insp. Report _____
Schedule Symbols - (Annual - □)(Semi-Ann. - ○)(Quarterly - △)(Monthly - X)

OK	Period	Part	Remarks	Last Insp.
	X	Insulators		
	X	Operating Mechanism		
	O	Oil		
	O	Tanks		
	O	Breathers		
	O	Explosion Chambers		
	O	Contacts		
	O	Contact Rods		
	O	Alignment of Rods		

General Remarks:

Inspection of oil circuit breakers is made according to the schedule indicated by the symbols

Week End. (Sun.) _____ 19__ Plant _____

Hours Operated Daily

Machine	Mon.	Tue.	Wed.	Thurs.	Fri.	Sat.	Sun.	Total
No. 1 Generator								
No. 2 Generator								
No. 3 Generator								
No. 4 Generator								
No. 1 Gov. Pump Mtr.								
No. 2 Gov. Pump Mtr.								
No. 3 Gov. Pump Mtr.								
No. 4 Gov. Pump Motor								
No. 1 M.G. Set								
No. 2 M.G. Set								
Battery Charging Set								

Daily record of generating-equipment operation

Month - _____ Plant _____ 193__

Record of Switch Operations by Relay

Note:- Under "Phase" denote target by letters A B or C (No target NT) O = Opened I = Date inspected

Since Last Insp. Date	Switch			Switch			Switch			Switch			Switch			Switch			Switch			Switch			Cause
	O	Phase	I	O	Phase	I	O	Phase	I	O	Phase	I	O	Phase	I	O	Phase	I	O	Phase	I	O	Phase	I	

Complete inspection of oil circuit breakers with the oil removed is made after six relay operations

In hydro plants is especially important in preventing interruptions to service, expensive insulation failures and possible injury to operators. Routine inspections by the technical staff should be followed up by daily inspection by each operator. Irregular operation must be reported and promptly handled. Scheduled dismantling and overhauling of all rotating equipment pays excellent dividends in searching out the weak spots to be repaired at reasonable expense, as compared with failure while in service. Excessive wear, too frequent replacement of parts and failures must be analyzed for inherent defects which must be eliminated by changes in design or construction to prevent recurrence. As an example, after the failure of a varnished-cambric insulated cable it was found that the duct was slightly damp. The cable was removed and replaced by a corona-proof rubber-insulated cable better able to resist moisture.

ELECTRICAL MAINTENANCE

In studying the maintenance of large generators, their inherent enemies must be kept in mind. Some of these are oil vapor, dust, insects (during summer), vibration of lamination and coils, overheating, shaft currents, poor lubrication, loosening of small parts, changes in alignment and condensation of moisture as a result of temperature changes. The first three troubles are being eliminated in some designs of generators by using a closed system of air circulation with water cooling. In other designs the prime consideration is the elimination

Report No. _____ Date _____

INSPECTION REPORT

TRANSFORMERS

LOCATION _____ MAKE _____

DESCRIPTION _____ PHASE _____

RATING: K.V.A. _____ PRIMARY VOLTS _____ SEC. VOLTS _____

INSPECTED BY - _____ DATE LAST INSP. REPORT _____

SCHEDULE SIMBOLS - (ANNUAL - □)(SEMI-ANN. ○)(QUARTERLY - △)(MONTHLY - X)

OK	PERIOD	PART	REMARKS	LAST INSP.
	X	BUSHINGS		
	□	WATER COOLING COILS		
	X	WATER PIPES		
	X	OIL		
	X	TANK		
	□	TERMINALS		
	□	RATIO ADJUSTER		
	X	THERMOMETER		
	X	INERTAIRE SYSTEM		
	□	CONNECTIONS		
	□	INSULATION (MEGOHM - METER)		
	□	CONSERVATOR TANK		

GENERAL REMARKS:

Inspection report form for transformers, inspections being made according to the schedule symbols

of sources of oil vapor. Dust will not accumulate as readily on a dry surface and it may easily be dislodged by an air blast. Where insects get into the cooling system and lodge in the ventilating ducts of the stator, their number may be reduced by screening all air inlets to the generator. It is advisable to paint the winding of the generator at not less than two-year intervals. The intervals between cleanings will depend on the conditions outlined in the foregoing and on the temperature change of the winding. A rising temperature curve at the same loading will indicate necessity of cleaning.

Overheating of the winding from any cause will result in a short life for the insulation. The critical temperature varies with the type of insulation used; and its temperature limit should be obtained from the maker.

The laminated structure of the stator should be watched for any loosening of the finger clamps, and for bending of an air duct spacer, to prevent vibration of the laminae. If coils become loose in the slot due to shrinkage of their insulation the slot wedges should be driven again, with a spacer strip beneath.

Shaft currents are a grave danger to the bearings on a vertical generator. The deck arms are always—and sometimes the thrust bearing—insulated against circulating currents, which are due to the rotation of the parts in a magnetic field. An important feature of repair work is to make a test across this insulation after all assembly work on either side of the insulation is complete. A direct-current voltage of 250 is our usual practice for testing. This sometimes requires dismantling a guide bearing, but the test is imperative because of the many opportunities for something to bridge the insulation. Also, it is essential that no temperature indicators or new pipe works be placed on the generator unless the job is carefully installed and tested to insure that the insulated gap is maintained by the new work.

Excessive condensation of moisture on a unit when shutdown or subject to variations of temperature is guarded against by the installation of space heaters under the stator winding. From 8 to 20 kw. in heat is supplied, depending on conditions.

Exciters are examined on each shift for too tight fit of brushes in brushholders, even temperature of current-carrying parts and for any condition affecting the operation of the machine. Streaked and blackened bars are reported. A monthly inspection is made and the condition of everything is noted on a form. If a light uniform gloss on the commutator is not readily maintained a search for the cause of the trouble is made until it is found and eliminated. This policy is extended to all commutators, and machines with undercut mica are blown out frequently with compressed air, the recess between the bars being cleaned out monthly.

There has not been a commutator failure in any of the plants on our system; one plant is over eleven years old. The life of the commutators is expected to equal the life of the machine, but this is only possible with extreme vigilance. When grooving of commutators first appears, the commutator is dressed with a fine handstone and polished with canvas. As previously stated, the trouble is not allowed to persist. Very seldom has it been necessary to turn a commutator in a lathe or with a grinder.

Oil switches on generators and oil circuit breakers on high-tension lines are scheduled for complete inspection, lubrication and repair, with the oil removed at annual intervals or after six relay operations, if the latter

REPORT NO. _____ DATE _____

INSPECTION REPORT

SWITCH BOARDS AND RELAYS

LOCATION _____ MAKE _____

DESCRIPTION _____

INSPECTED BY _____ DATE LAST INSP. REPORT _____

SCHEDULE SYMBOLS - (ANNUAL - □)(SEMI-ANN. ○)(QUARTERLY - △)(MONTHLY - X)

OK	PERIOD	PART	REMARKS	LAST INSP.
	△	INDICATING METERS		
	△	RECORDING METERS		
	X	RELAYS (MECHANICAL)		
	□	RELAYS CALIBRATION		
	X	KNIFE SWITCHES		
	X	CIRCUIT BREAKERS		
	X	PILOT LAMPS		
	X	CONTROL SWITCHES		
	△	WIRING AND CONNECTIONS		
	△	CONTACTS		
	X	PRESSURE GAUGES		
	△	BUS		

GENERAL REMARKS:

Inspection report form for switchboards and relays, inspections being made according to the schedule symbols

is a shorter time interval. Frequent inspections are made on the control switches, and closing mechanism and contacts are cleaned and terminals tightened if necessary. The centrifugal devices have sufficient vibration to loosen screws and bolts in a short time. The instruction book of the maker is followed closely on adjustments, and all wearing parts are checked for effect on operating characteristics. For instance, a buffer, if worn, will sometimes allow the mechanism to get out of adjustment and permit the breaker to open.

High- and low-tension disconnects receive a good measure of attention, and the contacts are cleaned and lubricated as well as all moving parts, at regular intervals. Once a year usually suffices.

Compensators, starting switches and other inclosed current-breaking devices are opened and cleaned and adjusted once a year, or oftener if the severity of the service shows the device to be in poor condition after a year's service.

Motor-powered devices used for emergencies are operated at regular intervals to insure that no damage has occurred while the machines have been idle. A motor of this type may suffer from ills due to corrosion or moisture if not properly protected and tested. One example is the motor-operated fire-extinguisher valve.

Week End. (Sun.) _____ 19__ Plant _____

No. of New Brushes Used

Machine	No. Brushes Used A. C.	No. Brushes Used D. C.	Style A. C.	Style D. C.	Length of Brush Discarded
No. 1 Gen.					
No. 2 Gen.					
No. 3 Gen.					
No. 4 Gen					
No. 1 Gov. Pump					
No. 2 " "					
No. 3 " "					
No. 4 " "					
No. 1 M.G. Set					
No. 2 M.G. "					
Battery Chg."					

Record form for brushes used on generators and motors

Switchboards are blown off with a hand bellows once a month. Contacts on control switches are cleaned every six months. Worn parts are replaced when necessary before an open circuit or other failure occurs. Transfer switch for reading three circuits on one ammeter may give trouble if not watched. One ammeter per circuit is used in later-design plants to eliminate the transfer switch.

Watt-hour meters are cleaned, adjusted and calibrated every three months. Relays have the same treatment every six months. Other devices, such as voltage regulators and automatic telephone boards and signal systems have routine inspections and tests as found necessary, including manufacturers recommendations.

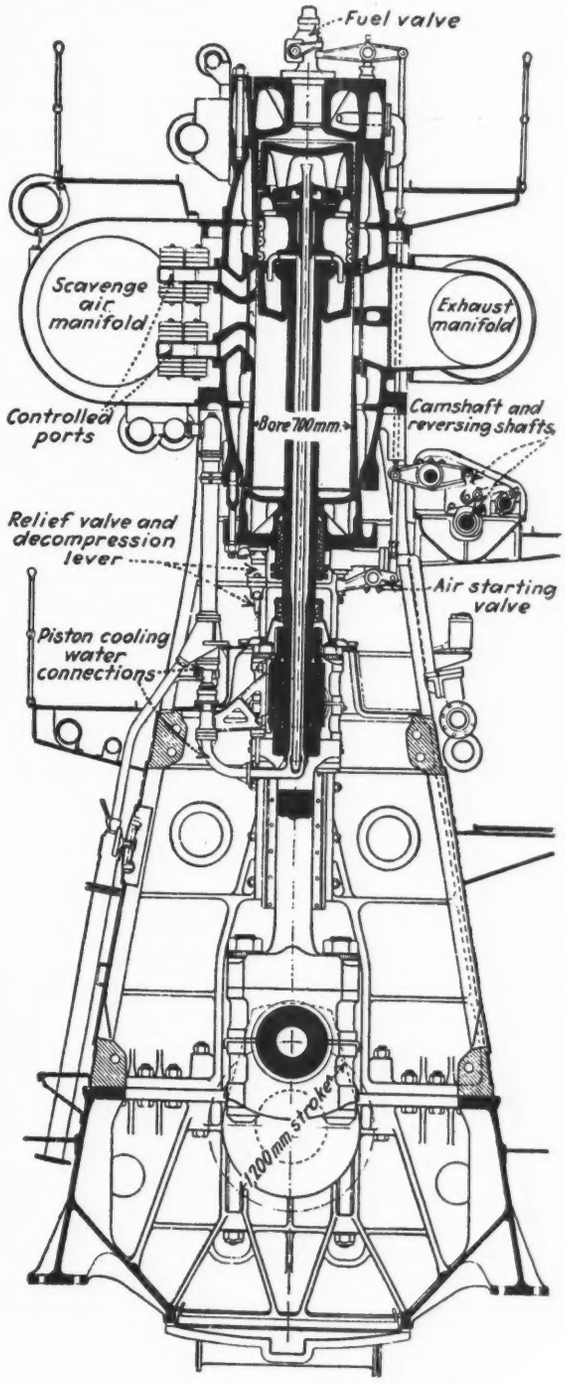
Spare parts are kept in good condition in temperature-regulated rooms, and ferrous parts are treated with rust preventive.

Sulzer Brothers Build a Double-Acting Diesel

FOR YEARS Sulzer Brothers, Winterthur, Switzerland, have adhered to the single-acting diesel engine, although, for capacities up to 7,000 hp., this called for unusually large cylinders. The firm's decision to construct a double-acting diesel is not without significance.

This engine, a cross-section of which is here reproduced from *The Engineer* of London, is rated 7,600 hp. at 106 r.p.m. Each of the eight cylinders has a bore of 27.56 in. and a stroke of 47.24 in. The engine is to be installed in the "Tajandoen."

Standard Sulzer design is employed in the top cylinder head, while the lower head is provided with a central



Cross-section Sulzer Brothers double-acting two-stroke-cycle diesel

opening for the piston rod and four openings, spaced about the rod opening, for the fuel-spray valves. Both the top and bottom spray valves are operated by a single camshaft, reversing being accomplished by shifting the position of the fuel valve rocker arm cam roller.

The secondary scavenging ports are fitted with steel strip valves, employed by the Busch Sulzer Brothers Company for several years in preference to the poppet valves employed by the Swiss firm. A single set of primary scavenging ports suffices for both cylinder heads, which permits of a reduction in the over-all height.

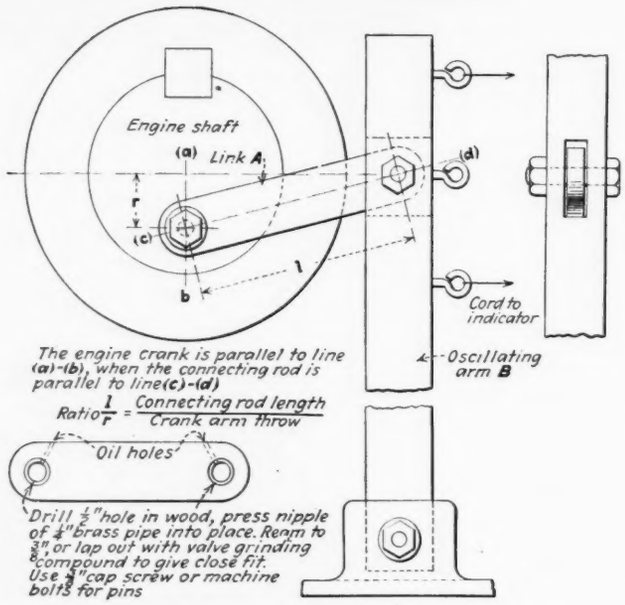
The engine frame is carried up to receive the box-like exhaust portion of the cylinder jacket, and both heads are held to the jacket by the studs. Stresses are then taken up by the frame, rather than by long tension rods, which are sometimes employed to reduce engine weight. No novelty is shown in the cylinder liners, which are clamped at the outer ends by the heads and joined at the center with a lap to permit of lengthwise expansion.

Cooling of the piston is by water entering and leaving through connections at the crosshead, with telescopic outer pipes isolated from the crankcase to prevent oil contamination.

Scavenging air is supplied by two tandem pumps placed at the end of the frame adjacent to the air compressors. Surprisingly, the fuel pumps are driven from the crosshead of the air compressors, something American engineers would not relish.

▼ ▼ ▼

Indicator Reducing Motion for Internal-Combustion Engines


Engine shaft
(a)
Link A
r
(c)
l
b
(d)
Cord to indicator
Oscillating arm B
The engine crank is parallel to line (a)-(b), when the connecting rod is parallel to line (c)-(d)
Ratio $\frac{l}{r}$ = Connecting rod length / Crank arm throw
Oil holes
Drill ⅛" hole in wood, press nipple of ¼" brass pipe into place. Ream to ⅜" or lap out with valve grinding compound to give close fit. Use ⅜" cap screw or machine bolts for pins

Reducing motion is attached to end of crankshaft

A REDUCING MECHANISM suitable for use in taking indicator diagrams on an internal-combustion engine, or any engine where there is no crosshead or where access to the crosshead is difficult, is illustrated. It consists, primarily, of two links—link *A* being joined to the engine shaft and link *B* ending in a pin placed in the floor bracket or on the engine base.

Link *A* is attached to the end of the main crankshaft in line with the crank. This is of great importance; but should an error be made in locating the stud to which link *A* is attached it may be corrected by changing the position of *B* slightly. Link *A* should be of such length that the ratio of $\frac{l}{r}$ in the sketch is the same as the ratio of the connection rod to the crank length in the engine being tested. Link *B* should be 20 or 30 times as long as the distance *r*, the longer the better. This allows the travel of link *A* to approximate very nearly the condition of being guided as in a crosshead. Link *B* should be so located that its travel to either side of a vertical line is about equally divided.

This mechanism gives the effect of a connecting rod and crosshead mechanism without the labor of planing guides and erecting them. Also, different lengths of indicator diagrams may be taken by having several points of attachment (see eye-bolts in link *B*), provided the cord travels two or three feet in a straight line before passing over a pulley.

A simple type of construction which requires no machine tools to make is used. The links are made of any good tough wood (gum, oak and magnolia have been used with equal success). A ½-in. hole is drilled with a wood bit at the point where a pin joint is required. A piece of ¼-in. copper pipe (not tubing) is then dressed slightly with a file and twisted or pushed into the hole. The pipe is then cut off flush with the wood with a hacksaw. The hole through the pipe is reamed to ⅜ in. The inside diameter of a ¼-in. pipe is so near to the required ⅜-in. that it may often be lapped out with a little valve grinding compound. A ⅜-in. machine bolt is then used as the pin. This gives a steel pin and a copper bushing or bearing which fit nicely, but the total weight of the link is small. Such construction was used in making the reducing mechanism illustrated. Oil holes may be drilled through the wood and the bushing as shown.

Modern Operation

will be the theme of next week's number —August 25 *Power*.

In it the operating engineer will find the key to many of his newer problems.

The care and handling of major equipment employed in power generation and power services will be dealt with from the practical and economic standpoints.

It should awaken in him a fuller appreciation of the scope and intricacies of present day operation, its added responsibilities and the opportunities offered.

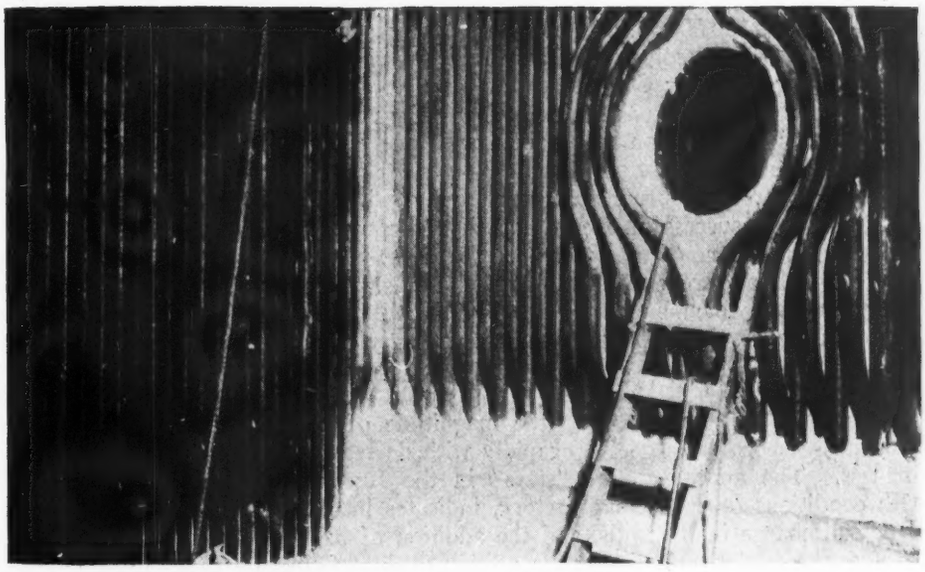


Fig. 1—Southwest corner of No. 3 boiler from inside

By A. B. STICKNEY
Fred Ophuls & Associates

Burning Low-Quality Coal At Anheuser-Busch Plant

Burning coal of extremely low quality, it is found that fineness of pulverization has an important effect on the carbon loss in the ash

AT THE new Anheuser-Busch power plant, St. Louis, Mo., described in the June 17, 1930, number of *Power*, operating experience has defined the limiting conditions for non-slagging operation. These boilers are operated on pulverized southern Illinois coal up to 370 per cent rating without any slagging whatever, under the proper conditions.

The characteristics of the furnace were given in the general plant article. In brief, the furnace is square, with a hopper bottom. Front, back and sides are bare 3-in. tubes on 3½-in. centers. Hopper bottom is made of 3-in. tubes on 3-in. centers, covered with a thin tile. The only exposed refractory is a small triangle at each end of the hopper (where its influence on radiation is negligible) and narrow strips between the tops of the front and rear walls and the bottom row of boiler tubes, all of which were due to structural requirements.

Each furnace is fired with pulverized coal by two unit systems, each consisting of a ball mill and turbulent burner. Furnace volume is 8,750 cu.ft. Projected water-wall area is 2,016 sq.ft. Each furnace is placed under a 10,760-sq.ft. Springfield boiler.

Coal of Very Low Quality

The coal is O'Fallon, St. Clair County, Illinois, coal, having approximately 20 per cent ash, 10 per cent moisture, 5 per cent sulphur, 35 per cent volatile, 10,200 B.t.u., and an ash-fusion temperature of approximately 2,000 deg. F.

Maximum designed rating is 137,000 lb. per hour of 450-lb., 600-deg. steam from 350-deg. water. This means an energy liberation of 164,000,000 B.t.u. per hour. While this is 370 per cent boiler rating, the furnace liberation rate is only 18,750 B.t.u. per cubic foot.

Operating experience shows the boilers may be

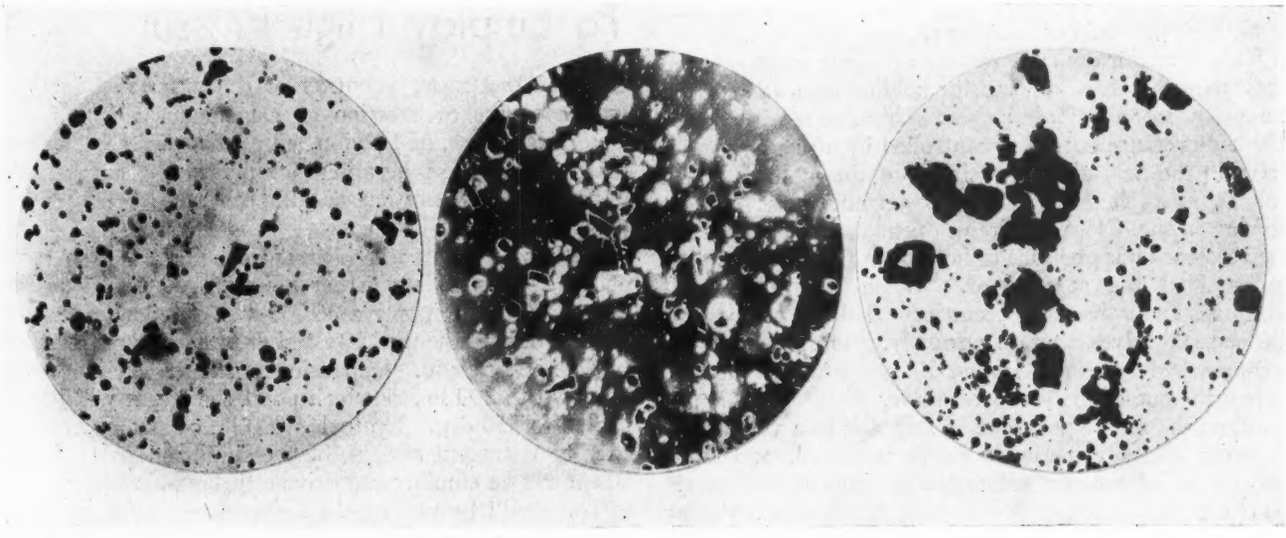


Fig. 2—Sample of ash passing through a 325-mesh screen (123 magnifications)

Fig. 3—Sample through 325-mesh screen (123 magnifications) with polarized light

Fig. 4—Unscreened ash containing 7.32 per cent carbon. Operation at 14.3 per cent CO_2 (123 magnifications)

operated up to 100,000 lb. of steam at 15 per cent CO_2 and, with CO_2 gradually falling off to 13 per cent, up to full rating. Higher CO_2 sometimes leads to slag at the entrance to the first pass. At the low ratings steady combustion conditions can be obtained with one burner down to about 40,000 lb. of steam.

Proper control of burner turbulence and of fineness are essential to successful operation. With improperly controlled turbulence of the burners, it is easy to plaster the rear wall and rear hopper slope with a slag and carbon deposit which builds up rapidly. With proper control, however, these portions are kept perfectly clean.

Unburned-Carbon Loss Depends on Fineness

It is interesting to note that the magnitude of the unburned-carbon losses goes up rapidly with decreasing fineness. The appearance of "stars" in the furnace, with conditions otherwise satisfactory, indicates insufficient ball charge in the mills, and the addition of balls through the feeder will clear this condition up in a few minutes. This is accompanied by a sudden rise in steam flow with the same coal feed, a clear indication of decrease in unburned-carbon losses.

Quantitatively, two tests for carbon content and fineness of ash, both good, are as follows:

	Test No. 1	Test No. 2
Per cent on 100 mesh	6.44	2.55
Per cent through 100, on 200 mesh	19.78	9.83
Per cent through 200, on 325 mesh	25.70	22.35
Per cent through 325 mesh	45.40	63.40

The remainder stuck in screens:

Carbon, per cent of ash	7.32	2.8
Carbon, per cent of coal	1.46	0.56

Separate analysis of the portions remaining on different screens shows that the carbon content ranges from 40-45 per cent, in the portion on the 100-mesh screen, down to practically nothing on the portion through the 325-mesh screen. Microscopic examination yields similar results, with the further interesting fact that the ash is translucent and spherical, indicating that the individual particles have been above the softening temperature during combustion, and have again cooled below this temperature before entering the first pass. Those with unburned carbon retain their shape.

The significance of the spherical shape of the ash particles is that it demonstrates that the furnace is operating at the limit of non-slagging operation.

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Automatic Unloading Of Synchronous Motors

By CARL C. NELSON
Control Engineer
Electric Machinery Mfg. Co.

SYNCHRONOUS MOTORS, having control which provides automatic resynchronization after having pulled out of step, must be provided with an automatic unloader if the pull-in torque is not great enough to bring the motor into synchronization. Automatic unloaders function to unload the motor during the starting period, or at speeds below synchronism, and after synchronization operate to load the motor. Thus with automatic unloaders it is possible to use a synchronous motor having low starting and pull-in torques. This is particularly true with motors for reciprocating loads, such as air and ammonia compressors.

Unloaders for air compressors are quite common, and ordinarily consist of devices for holding open the suction valves by means of air pressure from a receiver tank. The air-pressure cut-off is controlled by a magnetic pilot valve in the field-discharge circuit of the motor. When voltage is applied to the motor terminals the current flowing in the discharge circuit opens the valve, allowing the receiver tank pressure to hold open the suction valves and unload the compressor. When the motor synchronizes the valve closes, cutting off the pressure, and the suction valves operate normally. The same can be accomplished by utilizing an auxiliary contact on the field switch to control the magnetic valve.

When the motor pulls out of step due to a voltage dip or other cause it is immediately unloaded, and upon restoration of voltage automatically pulls into step, resynchronizing when provided with the frequency-relay field-responsive synchronizing system.

Similarly, magnetic clutches can be used for loading by energizing the clutch when the motor synchronizes. Energizing the clutch is controlled by an auxiliary contact on the automatic field switch.

Ammonia compressors can be made entirely automatic and used with thermostatic start and stop operation with an automatic bypass for unloading. Installations troubled with voltage dips function satisfactorily, pulling back into step automatically, when provided with an automatic bypass for unloading and a control system for resynchronizing.

Other synchronous-motor applications can be similarly provided with unloading devices with the assurance that entirely satisfactory operation will be obtained.

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Ford's English Plant To Employ High Pressure

IN A PRELIMINARY ACCOUNT of the new Ford factory, in the course of erection at Dagenham, England, the *Power Engineer,* of London, states that there will be two boiler plants, one generating high-pressure steam at 1,200 lb. for power generation, and the other 200-lb. steam for process work and heating.

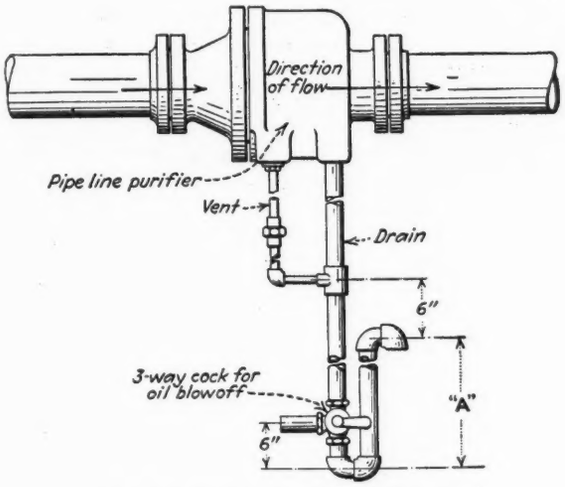
Each of the three high-pressure boilers will be rated at 205,000 lb. of steam per hour at 750 deg. F. Together they will supply a 30,000-kw., three-cylinder turbine, which will be the largest high-pressure unit installed to date in England. Expansion in the first cylinder will be down to 200 lb., at which point the steam will be reheated to 550 deg. Up to 155,000 lb. of steam per hour may be extracted at 200 lb. pressure, and part of this steam will be employed to drive a turbine-blower.

There will be two of the low-pressure boilers. It is planned to burn pulverized coal, supplemented by blast furnace gas, coke-oven gas, or waste heat from refuse incineration.

...RIGHT OUT OF THE PLANT...

Trapping Low-Pressure Steam Lines

THE ACCOMPANYING SKETCH shows how purifiers can be made to discharge direct to the atmosphere when installed in exhaust steam lines where the pressure is only a few pounds above or below atmospheric pressure. Dimension A should be 27.71 in. for each pound difference in pressure, plus about 12 inches.



Purifier traps moisture in steam line

If there is oil present in the steam, and there is the possibility that it might clog the pipe upon cooling, a three-way cock may be included as an oil blow-off. The cock should be used in this location only on pressure lines, not on vacuum lines.

E. P. WILSON.

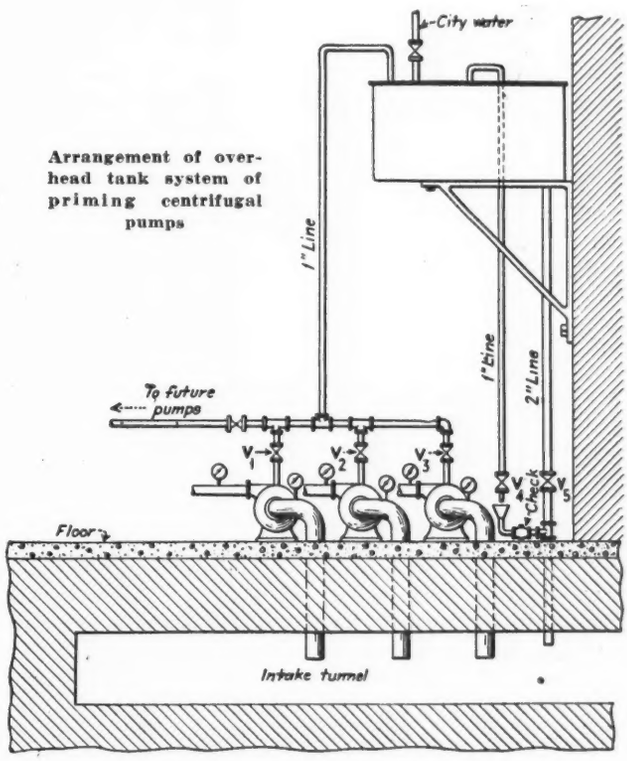
Cleveland, Ohio.

Overhead Tank Method of Priming Centrifugal Pumps

THERE ARE many different ways of priming centrifugal pumps, and the best depends on the general arrangement of the equipment. A method we have found to be satisfactory is shown in the accompanying illustration.

A tank of about twice the capacity of the largest suction line is erected at the highest convenient point in the plant. This head is made sufficient to offset the lift from the supply water level to the horizontal axis of the pumps. One-inch nipples and globe valves are placed on the priming connection at the top of each pump housing. These are connected together and a one-inch line is run to the top of the tank. A 2-in. line from the bottom of the tank is carried to any suitable discharge point, with a valve in easy reach from the floor level. A one-inch vent line connected with the top of the tank is carried down to the floor, and discharges through a funnel as shown.

Assume this has just been installed and is to be used for the first time, with no pumps running. The valves are all closed. The vent valve to the funnel is opened and the tank filled by opening the city water valve. As soon as the vent indicates that the tank is full these two valves are closed and the tank is ready to prime any pump. The priming valve on the pump to be started and valve V_5 are opened. As the water flows out of the tank the resulting vacuum, or syphon, will draw the supply water up in the suction line. As soon as the pump is full of water, which may be ascertained by sudden fluctuation of the suction vacuum gage or by feeling the priming line, the pump may be started and the 2-in. valve V_5 closed. The vent is opened until the pump fills the tank again through the priming line and valves V_1 and V_4 are closed. The tank's being kept full eliminates the necessity of filling with city water each time before starting a pump.



Arrangement of overhead tank system of priming centrifugal pumps

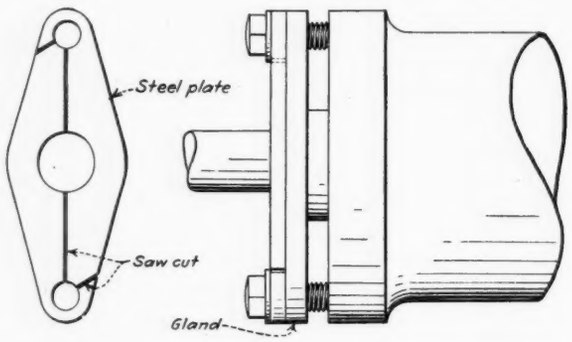
H. M. SPRING.

Milford, N. J.

Design of Reinforcing Plate for Cracked Stuffing Box Gland

AN ARTICLE in the April 7 number showing how a broken stuffing box gland was temporarily repaired was of interest to me, because I once experienced the same trouble. My method of repair, however, was somewhat different from Mr. Willey's.

Two $\frac{1}{8}$-in. plates cut out at one side so that they could be assembled over the pump rod, as Mr. Willey shows, would resist a bending strain equal to only one solid plate of the same thickness, and, in my opinion, a $\frac{1}{8}$-in. plate is hardly strong enough for the purpose. I made one plate only, of stock $\frac{1}{4}$-in thick, and to get it over the rod



Reinforcing plate designed for maximum strength

I cut it in two as shown in the illustration, leaving the plate with almost its original strength. To assemble the plate on top of the gland I laid one half on first and then let the other half into it. The two halves are thus locked and cannot be pulled apart sideways, and the pump rod prevents their being moved lengthwise. This feature I consider desirable to prevent half of the plate dropping out if the nuts should loosen a little under vibration. W. H. MOORE.

Hamilton, Ont.

Why the Water Softener Capacity Dropped Off

WE HAVE a zeolite 3-in. vertical single-unit water softener. Capacity of this unit was rated at 3,900 gallons of soft water per regeneration based on city water with a hardness of 20 gr. per United States gallon. After two years' operation the capacity of the softener dropped to about 3,500 gallons. Checking up, we found that the city had brought in a new well about the time the capacity dropped. A sample of the city water was sent in and tested by the makers of the softener. They recommended cutting the capacity to 3,300 gal. per regeneration, as the city water showed more grains of hardness per gallon. After operating another two years without trouble we found the same drop in capacity as before. This was not due to a change in the water, as the wells had not been changed.

The cover of the mineral tank was removed, and in one place about 1 ft. wide and extending from the center of the tank to one side we found a spot of rust. We started the backwash and found that the water did not come up through this part of the bed. The mineral was found to be packed very hard in this spot. The bed was stirred up with a rod until the water flowed up through this spot. When the backwash water was shut off we found that this rust was scattered all over the top of the bed instead of on one spot as before. The height of the mineral was found to be about 3 in. too low in the tank. This would account for the dirt not being removed when backwashing.

In the first batch after stirring up the mineral bed the softener ran out 3,300 gal. and showed over $\frac{1}{2}$ in. of lather on the water at the end of the run, using five drops of soap solution in 40 cc. of water.

The mineral bed of the softener does not need much care besides the regular backwash and charging with salt solution. About once a year it is a good plan to open the top and stir the mineral up, being careful not to stir so deep as to mix the gravel with the zeolite. The only thing to do when they become mixed is to remove the materials and separate them, which is not a pleasant job. W. W. DINGWALL.

Walthill, Neb.

Hand-Scraping of Oil Engine Bearings

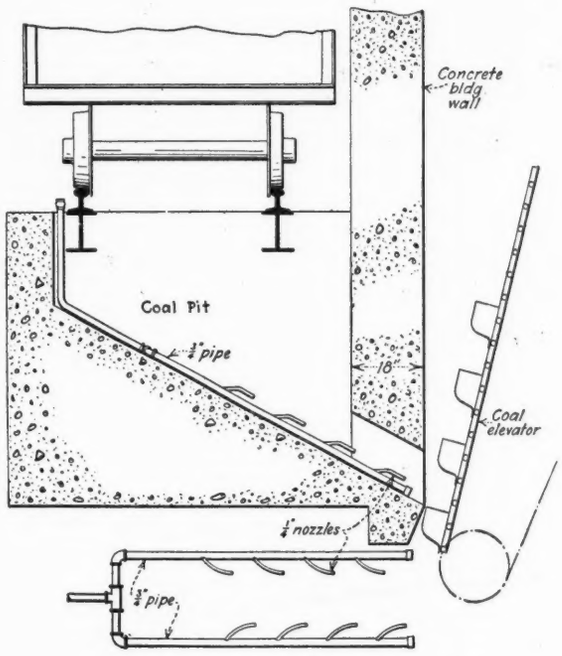
THE COMMENTS by C. J. Mason on page 998 of the June 23 number, referring to the article by L. H. Morrison on page 742, May 12 number, while interesting, do not probe the matter deeply enough. The method of boring out the bearings a small amount larger than the shaft is simply a modification of American marine engine practice of 70 or 80 years ago, when lubrication as we know it today was not thoroughly understood. Experiments have shown that in the case of a well-lubricated shaft running at high speed the journal never comes in contact with the bearing. It is supported by a film of oil. It must also be noted that this method is merely an evasion of misalignment and not a correction, and will not provide that unbroken and continuous thickness of oil film which the requirements of the high-speed oil engine demands today. The clearance allowed between crankshaft and bearings on high-speed oil engines of 400 hp. is 0.003 in., hence the necessity for perfect alignment and an unbroken film of lubricating oil.

There is also the other aspect of this problem of hand-scraping to which Mr. Morrison refers, and that is the area measured in square inches on which handwork is done. If we have a bedplate for an oil engine with a four-throw crankshaft, we have five bearing pockets each to be fitted with a bearing shell, and through faulty machining must be corrected by hand-scraping. Assume that these bearings are 6 in. diameter bore x 9 in. long, and $7\frac{1}{2}$ in. outside diameter x $7\frac{1}{2}$ in. between flanges. Then the area to be corrected by hand is equal to 20 sq.ft.—and that is only one part of the engine. We also have connecting rods and wristpin bearings, cylinder covers and camshaft bearings, etc. The sum total of all this handwork is the problem as visualized by Mr. Morrison. There is also the point of view of the owner of the oil engine, who expects that replacement of many parts should be carried through at the lowest possible cost in money and time, particularly time, as a comparatively lengthy shutdown is costly. DONALD RAEBURN.

Glasgow, Scotland.

Feeding Coal to Elevator With Compressed Air

THE ILLUSTRATION shows how we got around a difficulty in unloading a very fine dust-like grade of anthracite coal at our plant. This coal would not slide through the open-



Arrangement of compressed air nozzles in coal unloading pit

ing at the bottom of the coal pit when dumped from the cars, and gave us trouble until we rigged up the air pipe as shown. Now we turn on the air, open the car dump and the coal feeds through to the elevator nicely.

Wilkes-Barre, Pa. THOMAS M. STREET.

Size of Boilers for Laundry Plant

ON PAGE 28 of the July 7 number a question is asked in regard to the best size of boilers for a laundry power plant. I do agree entirely with the answer given.

A steam demand of 18,000 lb. per hour would mean 4 per cent overload on a 5,000-sq.ft. boiler, which is rather low, considering that this demand is the maximum. The total boiler surface to be installed should depend, first of all, on the kind of fuel and the method of firing. For stoker, oil or gas firing about 140 per cent load is the most economical; therefore, one 3,700-sq.ft. boiler would do, without regard to reserve and flexibility.

The requirements of flexibility will depend on the work done: Family laundries generally have heavy loads during the first two to four days of the week, tapering off gradually toward the end of the week. For such a plant one 2,000- and one 1,700-sq.ft. boiler might do well. Linen supply, hotel work, etc., will give a uniform load over the week; consequently no flexibility is required and one 3,700 sq.ft. boiler will do, without reserve.

The reserve will depend on available funds. If material future expansion is to be considered a larger boiler could be installed, with hand firing for the present and provisions for the installation of a stoker and a heat reclaimer in the future.

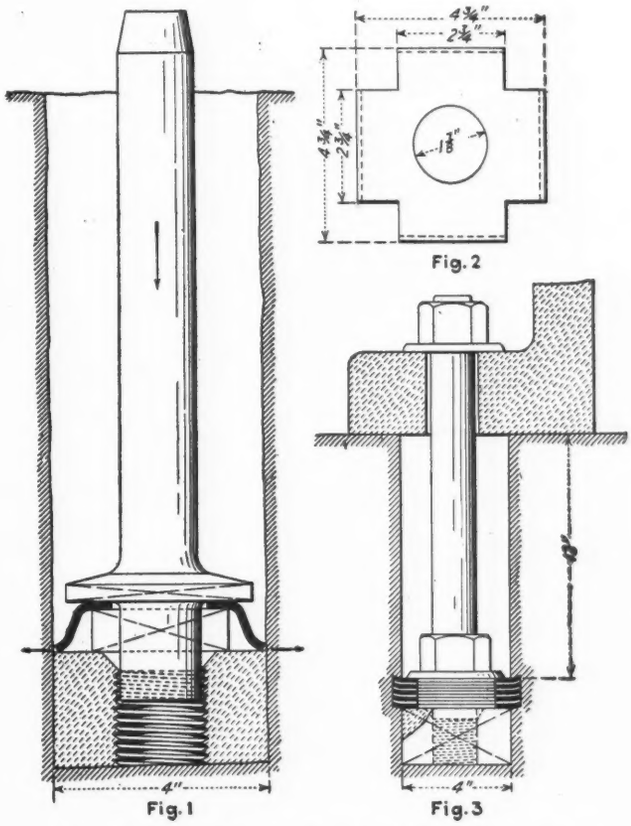
The statement that half of the steam is used for process, that is, for mangles, presses, etc., is somewhat misleading. Even in a full finished laundry not more than 30 per cent is used for that service. As suggested in the answer, the prospective plant is large enough to justify the employment of a consulting engineer to make a study of the situation. ANDREW A. BATO.

East Orange, N. J.

Gripping Foundation Bolts for Heavy Machines

THE TYPE of foundation bolt illustrated was devised at our plant for fixing heavy machines, as well as for steam, gas and oil engines. The device will be found particularly valuable when a rearrangement of some machine is desirable and when new machines are installed subsequently to the main foundations.

The essential idea in the design is a dished washer of steel plate, which on being expanded is forced into the sides of a hole cut to necessary depth in the stone or



Dished washers grip sides of hole when bolt is drawn up

the concrete foundation. The strength of such a grip is multiplied, at will, according to the number of washers used and expanded.

Referring to the illustration, the washers are first expanded in four directions, by hammer blows on a drift, as shown in Fig. 1, then the bolt and washer assembly is inserted with the concave side of the washers upward, the expansion being completed by drawing down on the top nut. Fig. 2 shows the washer as cut from ⅛ in. steel sheet and before it is bent to shape.

London, England. J. T. TOWLSON.

From Among Readers' Problems

Conducted by
L. H. MORRISON

RECONNECTING AN INDUCTION MOTOR—*If a 3-phase, 5-hp., 500-volt, 1,500-r.p.m., 25-cycle induction motor is connected series-star and is reconnected two-parallel star, will it operate satisfactorily on 220 volts?* M.R.

The motor when connected two-parallel star will be good for 250 volts and will operate as one designed for this voltage on 220 volts. Its horsepower will be reduced in the ratio of 250 to 220, or from 5 to 4.4 hp. The original motor winding may have been liberally designed and so will carry a 5-hp. load when reconnected two-parallel star. The starting torque and the pull-out torque will vary as the square of the voltage, or in the ratio of $(250)^2$ to $(220)^2$, and will be about 77.5 per cent of what they were for the 500-volt winding. The efficiency of the motor will be decreased, because the losses will be practically the same as for the 5-hp. output; but theoretically the motor is good for only 4.4 hp. Unless the motor has to operate under severe conditions it should work satisfactorily when reconnected two-parallel star, but it should not be expected to drive a 5-hp. load unless the original winding has some excess capacity.

—◆—

GRINDABILITY OF COAL—*What is meant by the grindability of coal, and how may it be measured?* A.C.L.

Rittenger's law, which states that the work done in grinding is proportional to the new surface produced, is now generally accepted as being approximately correct. Mechanical screening offers a practical method for measuring the surface of all particles in a sample. For example, if a 1-in. cube is split into eight ½-in. cubes, each of these small cubes will have three new faces in addition to the three old ones, or the surface of each ½-in. cube will be double the original surface. Rittenger's law can, therefore, be restated: The work of grinding is proportional to the reciprocal of the diameter of the particles, which can be determined by screening.

R. M. Hardgrove recommends, in a paper presented before A.S.M.E. Fuels Division, April 20, 1931, the following procedure for determining grindability:

1. Prepare the coal sample so that all particles are practically the same diameter.
2. Subject the sample to a definite pulverizing process.
3. Screen the partly pulverized sample and determine the increased surface produced.
4. The final surface of the sample is obtained by applying constants, which are proportional to the reciprocal of the diameters of the particles. The new surface is obtained by subtracting the original surface.
5. Relative grindability is obtained by comparing the new surface to that obtained in a similar way on a coal selected as a basis of comparison.

The table shows a sample screen analysis and the calculation of surface units by multiplying the screen analysis by the factors in the third column. If the new surface units of a standard sample are 29,961, grindability is 16,840 ÷ 29,961 = 56.2 per cent.

Screen Mesh	Per Cent of Sample Between Two Screens	Factor	Surface Units
16-30	24.4	29	708
30-60	36.0	61	2,196
60-100	13.8	129	1,780
100-140	7.2	202	1,454
140-200	3.8	285	1,084
200-230	1.6	377	602
230-300	2.4	465	1,116
Through 300	10.8	1,000	10,800
Final surface			19,740
Less original surface			2,900
New surface units			16,840

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

WE ARE EXTENDING our 150-lb. steam line to supply a new turbine. The new pipe is 4 in. in diameter and will be insulated with 1½ in. 85 per cent magnesia. From the main it extends 120 ft. and rises vertically fifteen feet to the turbine. What should be the capacity of the trap installed to drip this line at the heel of the vertical rise? The horizontal run is pitched away from the steam main. R.W.B.

TO ESTIMATE the amount of condensate that would be discharged from the 4 in. line 135 ft. in length it would be necessary to know the minimum temperature of the air surrounding the pipe. Since this has not been given I shall assume it to be 40 degrees.

The temperature of the steam in the pipe at 150 lb. gage pressure is 366 deg. The temperature difference between the steam in the pipe and the air surrounding it is 366 — 40 = 326 deg. The heat loss in B.t.u. per hour per lineal foot of bare 4-in. pipe with a temperature difference of 326 deg. is 1,322. The efficiency of 85 per cent magnesia pipe covering is 88.3 per cent. The B.t.u. loss per lineal foot with this covering would therefore be 0.117 × 1.322 = 154.6.

The total loss in the pipe line per hour from radiation would be 154.6 × 135 = 20,871 B.t.u. The latent heat of steam at 150 lb. gage being 856.8, the condensate to be discharged per hour would be 20,871 ÷ 856.8 = 24 pounds.

It would appear that a very small capacity trap would be ample, but there are several points to take into consideration when deciding on the size of a steam trap. Peak or emergency conditions will arise. Should a trap be installed with a capacity only equal to the demand it would blow at very frequent intervals. This is objectionable. The wear and tear on a trap that is constantly in operation is considerable. On the pipe line in question a trap with at least 750 lb. capacity per hour should be installed. P. C. CONSTABLE.

McMasterville, Quebec.

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IN ESTIMATING the capacity of the steam trap for handling the condensate drainage from a 4 in. insulated pipe 135 ft. long there are a number of factors to be considered.

1. The amount of condensate formed due to radiation losses from the insulated line.
2. The amount of moisture carried over in the steam and dropped out in its travel through the pipe line.
3. The boiler water conditions may be such that considerable mud and sludge deposit must be taken care of in addition to condensate.

The expected amount of condensate due to radiation loss through the in-

sulation may be determined as follows:

The external surface of 135 ft. of 4-in. pipe is 1.179 × 135 or 159 sq.ft. With steam at 150 lb. gage the wall temperature is 366 deg. From insulation tables, the heat loss per square foot of pipe surface per hour for 1½ in. magnesia is 118.4 B.t.u. at the above temperature and pressure. The total heat loss per hour from the pipe line is 18,820 B.t.u., or, say, 22 lb. condensate per hour.

In Item 2, experience should govern in considering the possibility of carryover from the boiler, together with the quantity of steam being handled per hour to the turbine. We have used a factor of 5 per cent of normal hourly steam flow as being the trap capacity factor. Assuming a steam flow of 15,000 lb. per hour, then the trap capacity required would be 750 lb. per hour. This quantity can be safely handled by a ¾-in. inverted bucket-type trap and have some spare capacity.

Then comes the selection of the trap, and the first factor to be considered is reliability of performance. This depends on several factors, such as type of interior mechanism, non-air binding characteristics, elimination of mud and sludge. GUY L. WARDEN.

Los Angeles, Calif.

The steam trap capacity necessary to take care of the actual condensate formed in a 4-in. turbine supply line having a horizontal run 120 ft. and a vertical rise of 15 ft., all efficiently lagged, is small theoretically.

There are, however, several factors beside the normal rate of condensation in the pipe line which should be given consideration in making a steam trap capacity selection.

In the first place the capacity required during the warming-up period is several times that required to handle the normal condensate after the line is hot. The quality or superheat of the steam has a bearing, but most important of all is the possibility of the occurrence of slugs of water in the steam line. To handle slugs quickly and efficiently the trap should have considerable capacity even though computation indicates that small amounts of condensate will be formed during normal operation.

If the possibility of slugs of water in the steam line exists, and it usually does, I strongly recommend the installation of a receiver separator in the turbine supply line having a generous water storage space, and a ¾-in. steam trap of approximately 1,200 lb. per hour capacity. Such a trap is not large and it should be piped from the separator with at least ¾-in. pipe and bypassed with three valves so that it will be possible to remove the trap from the line during turbine operation.

With a separator-trap combination as described, comparatively large slugs of water, if present, will be removed from the line and retained in the separator storage space, thus providing time for the trap to discharge the water collected.

A trap having a capacity of 1,200 lb. per hour should be sufficiently large to handle slugs from the separator quickly, and during normal operation would have sufficient overcapacity to insure a minimum of wear. P. L. ULRICH.

Three Rivers, Mich.

SINCE IT was not stated whether the steam was wet or dry and the velocity of the steam was not given, these values must be assumed. We may assume a moisture of 2½ per cent and a steam velocity of 8,000 ft. per minute. For these conditions the condensation would be about 390 lb. per hour due to the moisture carried over with the steam. This value was obtained by solution of the formula $C = 60\ A \times V \times W \times P$, where C = condensation in lb. per hr., A = internal area of pipe in square feet, W = weight of one cubic foot of steam at the given pressure, P is the percentage moisture and V is the steam velocity in feet per minute.

For an insulation of 1½ in. of magnesia on a 4-in. pipe the radiation will be 0.355 B.t.u. per square foot per hour per degree difference in temperature. For a 4-in. pipe there are 1.179 sq.ft. per lineal foot of pipe. Since the pipe line is 120 ft. long, the total radiation area will be 120 × 1.179 = 141.8 square feet.

At a steam pressure of 150 lb. gage the temperature is 366 deg. Assuming an outside temperature of 60 deg., the temperature difference is 306 deg. Then the total heat loss per hour will be 0.355 × 141.8 × 306 = 14,500 B.t.u. per hour.

The heat of vaporization of steam at 150 lb. gage is 856.8 B.t.u. per pound. Therefore, dividing 14,500 by 856.8 will give the steam condensed per hour, or 17 pounds.

The total condensation will be 390 + 17 = 407 lb. per hour. Assuming a factor of safety of five to allow for slugs of water which may be carried over, the capacity of the trap should be 5 × 407 = 2,035 lb. per hour.

To insure separation of the moisture from the steam, a steam separator should be used at the point in question.

Denver, Colo. A. C. RASMUSSEN.

A Question for Our Readers

WE SHALL shortly place in operation a new turbine that exhausts at 50 lb. pressure to process. Which will be the best practice, and why: to operate the unit against atmospheric back pressure while starting, or to bring the unit up to speed while exhausting against the pressure in the process-steam line?

F.X.R.

Suitable answers, if received promptly, will be paid for[1] when published

IT IS OBVIOUS that R. W. B. is concerned with the condensation of 150 lb. steam that will occur in his 120-ft. insulated turbine branch due to radiation of heat from the covered surface to the atmosphere. The state of the steam entering the turbine branch from the steam main is not given completely, although if the pressure is not reduced between this point and the source or superheated at the source, the steam is certain to be wet, having a quality of less than 100 per cent.

If we assume an 86-deg. atmosphere the temperature drop between the steam and the air will be 366 — 86 = 280 deg. If the nominal pipe size is 4 in. its outside diameter will be 4.5 in. and the outside diameter of the insulation surface will be 4.5 + 3 = 7.5 in. The area of heat-radiating surface will be $\frac{120 \times 7.5 \times 3.14}{12} = 235$ sq.ft. The heat loss will be 0.375 B.t.u. per hour per square foot of outside cover surface per degree temperature drop, or 0.375 × 235 × 280 = 24,700 B.t.u. per hour.

The heat change in each pound of steam condensed will be the total heat of steam at 150 lb. and 366 deg. minus the total heat of water at the same temperature, or 1,195 — 338 = 857 B.t.u.

Therefore, the condensation that will occur due to radiation will be $\frac{24,700}{857}$ = 29 lb. per hour.

Since superheaters are probably not used and the steam not throttled ahead of the turbine branch, the steam entering the branch may have as much as 2 per cent moisture content. It would therefore seem good practice to determine the moisture content of the steam leaving the main by a calorimeter and from the results determine the total amount of water to be handled by both a separator and trap at the heel of the 15-ft. rise. It may be that the amount of water formed due to radiation from the 120-ft. branch is meagre compared to the moisture content of the steam entering this branch. In any event a very small and inexpensive trap will easily discharge the water collected by the separator. H. J. BYRNE.

San Francisco, Cal.

[1] As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.):

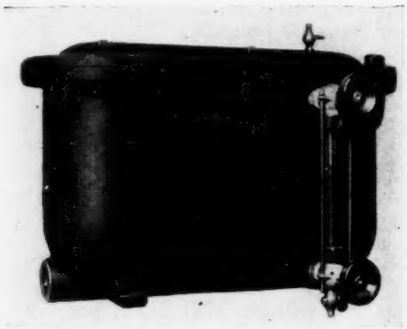
Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

WHAT'S NEW IN PLANT EQUIPMENT

Water Level Control for Low-Pressure Boilers

THE WATER LEVEL CONTROL illustrated is designed for use with low-pressure boilers. It consists, essentially, of a closed casing connected to the boiler at points above and below the normal water level.

In the casing two valves, one an inlet, connected with the source of water under pressure, and the other an outlet



Sterling water level control

valve to the boiler, are operated by a single float. Both valves are submerged in the water in the casing. Counterweights are provided to close the inlet valve. The complete valve- and float-operating mechanism is mounted on a flange and is removable as a unit. The control is put out by the Sterling Engineering & Manufacturing Corporation, Hyde Park, Boston, Mass.

Variable-Speed Hydraulic Transmission Unit

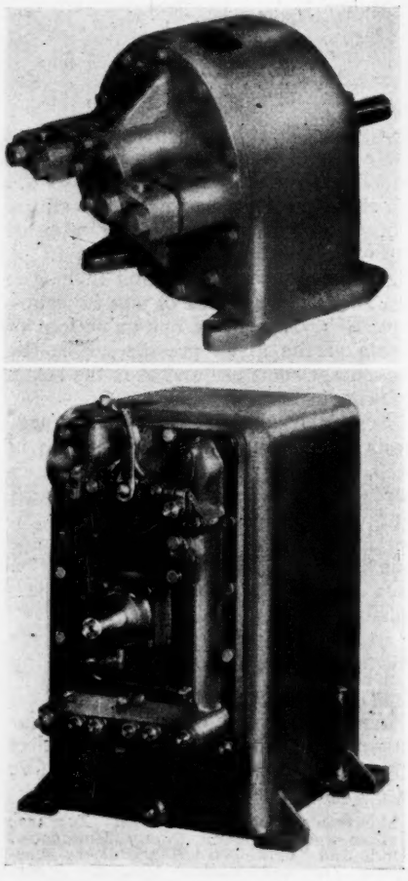
A 1,500-LB. constant-displacement fluid motor is announced by the Oilgear Company, Milwaukee, Wis., for use in combination with its variable-delivery pump to provide a variable-speed transmission. These units can be applied to conveyors, paper mill drives and other machinery where smooth rotary motion and variable speed are required. Also to reciprocating table drives for grinders and similar machines by means of a control valve, rack and pinion.

A series of speed ratios practically independent of variations in load are available with the Oilgear transmission. Any constant-speed source of power can be used to drive the Type QR-2 variable-delivery pump, and by varying its output the fluid motor can be varied from 0 to 800 r.p.m.

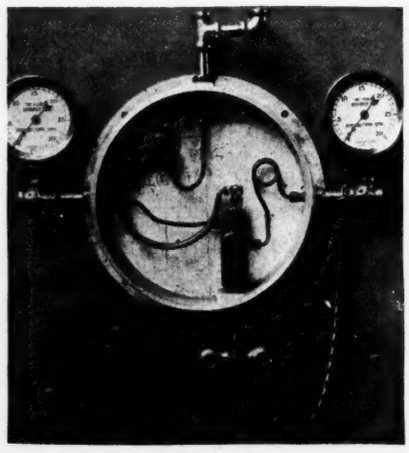
The Type RQ-2 motor has a displacent of 2.1 cu.in. per revolution. Its maximum recommended speed is 860 r.p.m. It is intended for use with a variable-delivery pump at a normal working pressure of 1,500 lb. per square inch and a peak pressure of 1,750 lb. per square inch.

The new 1,500-lb. pump is of the multiple-plunger type, with radially disposed cylinders, operating on the same principle as other Oilgear units. Stroke variation is accomplished by changing the eccentricity of the multiple-cylinder block with relation to the rotating piston carrier, which is on a fixed center and is driven by any source of power. Oil is delivered in one direction only from the pressure connection on the pump. A control valve can be used for reversing the flow of oil from the pump to the rotary fluid motor or reciprocating cylinder. The amount of oil delivered is controlled by a lever near the top of the pump, which varies the eccentricity of cylinder block and piston carrier, as previously explained.

Working parts used in the fluid motor are similar, except that the stroke of the pistons is fixed. The two units usually are connected by $\frac{3}{4}$-in. pressure and return lines, together with a $\frac{3}{4}$-in. drain line. Ordinarily the fluid motor rotates only in one direction, which can be reversed by interchanging the piping connections.



Type RQ-2 constant-displacement fluid motor for use as a variable-speed transmission and Type QR-2 one-way variable-delivery pump in standard oil casing



Fisher Type 4000 pilot controller

Pilot Controller

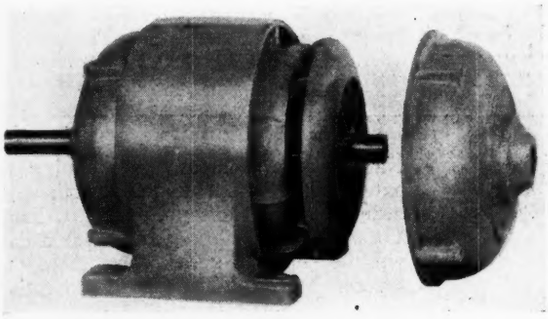
CLOSE CONTROL, full throttling in action, and the elimination of all mechanical lag are important features of the new pilot valve control, known as Type 4000, put out by the Fisher Governor Company, Marshalltown, Iowa.

The use of diaphragm and spring is eliminated, the change of the leak of the operating medium (air or gas) being accomplished by the varying position of the Bourdon tube, which is, of course, a function of the pressure therein. This tube is suspended free in the control, with resultant elimination of all contacts and friction.

Flexibility in construction allows a change from direct action to reverse action in the minimum of time, thus changing a pressure control valve to a back-pressure valve, or vice-versa, without delay. Change of pressure range is made by a change of Bourdon tube. Any control unit can be changed from low-pressure control to any range up to 2,500 lb. control pilot by fitting with a suitable tube.

This control, which is especially adapted to reduced pressure, back pres-

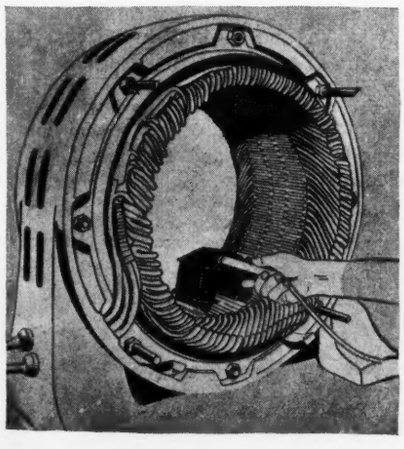
sure, boiler gas fuel and vacuum control, is furnished complete with gages and auxiliary operating medium pressure regulator. A modification can be furnished for control of differential pressure.



"Klosed-Tite" motor with mica and asbestos insulated windings

Fully Inclosed Fan-Cooled Motor

IN THE new totally inclosed fan-cooled motor ("Klosed-Tite") of the Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles, Calif., two iron housings completely incase bearings, air gap, rotor and windings. A fan on the end of the motor shaft forces cooling air across large external surfaces of the inner housing and out through openings in the other end. The inner housing is ribbed to increase the radiating surface. Lubrication is facilitated by oilers projected through the outer casing and extending to the inner bearing housing. "Lubri-Seal" ball bearings and labyrinth seals prevent the entrance of dirt into the bearings. The motor leads are sealed into the frame casting and are thus protected from ventilating air and the entrance of moisture.



Application of internal growler

Growlers for Testing Electrical Equipment

ADJUSTABLE GROWLERS specially adapted for locating "shorts," "grounds," and "opens" in armatures, stators and coils have been made available by the Ideal Commutator Dresser Company, Sycamore, Ill.

Essentially, the growler is an open magnetic circuit transformer with primary only (the wire on the iron core of the armature or stator coil acting as secondary when the magnet circuit is closed). The internal type illustrated is made in two sizes, hinged at the top. It can be used on stators with openings from 5½ to 60 in. in diameter. The external type is made in five sizes for armatures from ¾ to 30 in. in diameter. It is hinged at the bottom, and the armature under test is laid directly on the polepieces of the growler.

Oxweld No. 12 goggles

New Type of Welding Goggles

ADJUSTABLE eyepieces, ventilation ports on each side of the eyecups and increased field of vision by the use of 50-mm.-diameter lenses instead of the usual 47-mm. lenses are features of a new type of welders' goggles designated Oxweld No. 12. The eyepieces are joined with a leather strap, adjusted by means of a metal buckle, so that they may be correctly spaced to the width of the face. The ventilating ports are so constructed that it is impossible for sparks or light to reach the inside of the cup.

Brown color lenses, known as the "B" type, are available as with older goggles, and in addition a new special-quality green lens, known as the "A" type, is available in three different shades. Lenses may be easily changed by simply removing the metal cups, which unscrew from the frames of the eyepieces.

The material of which these goggles are made is a molded plastic substance known as Oxweldite, which is formed over a fabric base and is resistant to heat, light and electric current. The goggles are a recent development of the Linde Air Products Company, 30 East 42d St., New York City.

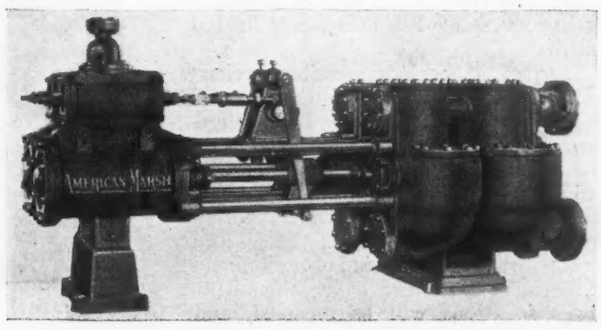
Improved Line of Steam Pumps

ALTHOUGH designed primarily for use in the oil-refining industry, the new line of steam pumps now being put out by the American Steam Pump Company, Battle Creek, Mich., is also well suited to high-pressure boiler feeding. The new line includes duplex-piston pumps of the side-pot, cargo, turret-top and valve-plate types, also simplex piston pumps of the side-pot, close-clearance type.

Referring to the illustration, which shows a close-clearance type unit, the steam end on both the side-pot and cargo pump is of the balanced piston-valve type designed for a maximum pressure of 300 lb. The two steam cylinders are separate castings and interchangeable for the right- and left-hand sides of the pump, each cylinder having its steam chest cast integral.

The fluid end is of the side-pot close-clearance pattern and built to order of the material specified. The two cylinders are separate castings, exactly alike and interchangeable. They are connected by separate suction and discharge Y-pipes.

Each pot is equipped with a number of small valves or with one large double valve as desired. The steam and fluid ends of the pumps are connected by eight tie bars, a set of four on each side of the pump. Various types of fluid-end valves and piston packings are available, as best suits the service for which the pump is to be used.



Duplex piston pump, side-pot, separate-pattern close-clearance type

NEWS of the FIELD

Universal Craftsmen Council of Engineers Holds 29th Annual Convention in Chicago

ONE of the best conventions in years was the consensus of opinion relative to the 29th annual meeting of the Grand Council of the Universal Craftsmen Council of Engineers, which was held at the Hotel Sherman, Chicago, Ill., from Aug. 3 to 7. From various sections of the United States and Canada 233 delegates, representing 63 councils, were in attendance, and in addition there were 125 delegates to the ladies' council.

Monday, Aug. 3, was devoted to registration and reunion of the delegates and visitors, with a reception and dance in the Bal Tabarin in the evening.

Tuesday morning the grand council convened in the convention hall of the Hotel Sherman to participate in the opening exercises, with William J. Weyker, chairman of the local committee officiating. Invocation by the Rev. Francis P. Morton was followed by an address of welcome by Frank Bering, managing director of the Hotel Sherman Company. Suitable responses were made by Clyde Gilmore, worthy chief of Chicago Council No. 1, Mrs. Diffendall, grand vice-president of the ladies' council, and William T. Wardell, grand worthy chief. Rev. R. Keene Ryan, grand chaplain, pronounced the benediction.

Business sessions were held each succeeding morning during the meeting. Afternoons and evenings were given over to entertainment and inspection of the exhibits, the former consisting of a theater party, attendance at a national ball game, exhibitors' night in the convention hall with eighteen vaudeville acts, an auto bus trip through the parks and boulevards, and a dinner-dance the final evening at which 800 sat at table.

Coordinated with the meeting was an exceptionally good exhibition of power plant apparatus and supplies, showing the products of 146 companies in 120 booths.

During the business sessions serious attention was given to the solution of the many problems existing in the engineering field. Active participation in the stimulation of business will be a policy of the order for the year to come. Membership and finances were reported in excellent condition. A noteworthy action was the decision to eliminate exhibits at the next convention. Instead donations will be received, and facilities provided for manufacturers to display literature.

Officers elected for the ensuing year are: Grand worthy chief, A. C. Elder, Los Angeles; grand assistant chief, Charles F. Kuechele, Washington, D. C.; grand secretary, Thomas H. Jones, Cherrydale, Va.; grand treasurer, John L. O'Brien, Chicago; grand warden, Paul D. Hutton, Buffalo; grand guard, A. L. Barnes, Milwaukee; grand chaplain, Rev. Samuel Rowland, Detroit; chairman of trustees, James Paton, Newark; senior trustee, L. J. Murray, Cleveland; junior trustee, Andrew Matson, Chicago. Cedar Point, Ohio, will entertain the next convention.

800-Mile Gas Line Placed in Operation

REPUBLIC GAS CORPORATION has commenced delivering gas from its reserves in the Hugoton field, southwest Kansas, to the Northern Natural Gas Company which is serving cities of eastern Nebraska and central Iowa through its new 800-mile pipe line system, it was announced last week.

The new system is designed for a capacity of more than 160,000,000 cu.ft. of gas a day and already represents an investment of $30,000,000. Northern Natural Gas Company is planning to extend the system further northward, ultimately to Minneapolis and St. Paul.

Up to 100,000,000 cu.ft. of gas a day will be supplied under contract to the system by Republic Gas Corporation from its reserves in the Hugoton field, comprising about 350,000 proven acres of natural gas holdings.

135,000 Kw. Being Added To Utilities P. & L. Plants

NEW STEAM AND HYDRO UNITS, totaling 135,000 kw. in capacity, are being added to the generating facilities of subsidiaries and controlled companies of the Utilities Power & Light Corporation, it is announced by the parent organization. Part of these additions are already completed, it is stated, while others are nearing completion.

The new units include a 35,000-kw. steam turbine-generator for the plant at Stourport, England, and a 5,000-kw. turbine for the steam station at Maccan, Nova Scotia. Among the extensions in the United States are the new 70,000-kw. steam generating station in Indianapolis, Ind. (known as the Harding Street plant), an additional 12,500-kw. unit in the Dubuque (Iowa) steam station, a 5,000-kw. and a 4,000-kw. steam unit for the Laclede Power & Light Company of St. Louis, Mo., a 3,000-kw. hydro-electric generating station at Lebanon, Mo., a 1,000-kw. steam unit at Harvey, N. D., and two small hydro-electric plants in Nebraska.

Members of the Universal Craftsmen Council of Engineers at the

Missouri Attempts to Regulate Gas Pipe Lines

TO DETERMINE whether or not it has the power to regulate pipe line companies supplying the state with natural gas, the Public Service Commission of Missouri has ordered the Cities Service Gas Company, controlled by Henry L. Doherty & Company, to file its industrial rate schedule and to submit to the provisions of the Public Service laws.

The company, which supplies natural gas through its subsidiaries to St. Louis, Kansas City, St. Joseph, Webb City, Carterville, Joplin, Carthage and other cities in Missouri, claims that it is engaged in inter-state commerce and is not subject to state regulation.

After investigation of the company's activities the commission holds that sales direct to large industrial consumers within the state, or to such customers through subsidiary distributing companies acting as agents, clearly constitutes intra-state business and comes within commission jurisdiction.

Because of the importance of the case it will be carried to the courts as was a recent similar attempt to regulate gas lines in Kansas. Anticipating such action, the commission has raised issues which are designed to obtain a final ruling on commission power over gas pipe lines.

Contractors Not Worried By Strike at Hoover Dam

THERE IS A FEELING in official quarters in Washington that the contractors on Hoover Dam have taken advantage of ill-advised action on the part of the workmen to close down their operations. Because of the extreme heat labor was very inefficient. For that reason it is suspected that the contractors are very glad to have this excuse to close down until the weather is cooler.

The trouble arose when 30 muckers were displaced by mucking machines. As muckers they were being paid $5 a day. They were assigned to work for which the scale was $4. They walked out and induced all other workmen on the payroll of the contractor to strike for higher pay.

The federal government apparently will not intervene. It is taking steps, however, to protect its property. A United States marshal has been ordered to Boulder City.

The contractor would not be penalized for the time lost because of the strike unless it could be shown that it was occasioned by some fault or negligence on his part. At present the work is nearly six months ahead of schedule.

Silver Bay Conference To Discuss Employment

"SECURITY OF EMPLOYMENT—Seeking a Solution" is to be the theme of the fourteenth annual Silver Bay Conference on Industrial Relations, which will be held at Silver Bay on Lake George, N. Y., from Aug. 26 to 29, inclusive. The conference will open on Wednesday afternoon, Aug. 26, with a statement by Charles R. Towson, founder of the conference, followed by an address on "Progress in Industrial Relations" by E. S. Cowdrick. In the evening Mrs. Lillian Gilbreth will speak on "Security of Employment—A Statement of the Problem."

On the remaining three days, sessions will be held in the morning and evening, leaving the afternoons for recreation.

Topics of the addresses and sectional conferences include: "An Experiment by a Company," J. T. Loree; "An Experiment by a Group of Industries," Marion L. Folsom; "Overcoming Seasonal Fluctuations," Glen Gardiner; "Unemployment Relief Measures," Albert M. Jones; "Railroad Problems," Roy V. Wright; "What's on the Workers' Mind," Whiting Williams; "Trend of Hours and Leisure Time," E. O. Otis, Jr.; "Vocational Tests and Training," Paul Viers; "Pensions," W. W. Stewart; "The Press and Public Opinion," H. C. Parmelee.

Dinner Dance in the Grand Ballroom of the Hotel Sherman, Chicago

News of Canada

Legislature may investigate Ontario Hydro Commission; central station output drops; $30,000,000 Manitoba project

WITH THE STORM and stress at Ottawa over the Beauharnois situation quieted for the time being, a new power war has broken out in Ontario political circles which may result in either a parliamentary or judicial investigation of recent contracts of the Ontario Hydro Electric Power Commission and its dealings with the Beauharnois corporation.

While opponents of the Hydro policy of purchasing power from private companies in the province of Quebec have been voicing their objections for some time, the demand for an inquiry was brought to a head with the revelation during the Beauharnois investigation that the Ontario commission had paid $50,000 to John Aird, Jr., of Toronto, in connection with the purchase of Madawaska power rights from the M. J. O'Brien interests in 1929. The commission claims that the money was paid for services in negotiating the purchase of the properties, but it has been charged that the $50,000 was paid to Mr. Aird for options on the property which he really did not hold.

However, the real object of the investigation, it is alleged, is to determine whether or not the Hydro has been justified in entering into contracts with five private companies in the province of Quebec to purchase a total of 891,000 hp. of electrical energy. Opponents of this policy state that the commission is unable to absorb all the power purchased from the Gatineau Power Company and that the Hydro plant at Queenston is running considerably under capacity. It is contended by some that future power requirements should have been arranged for by building more power plants in Ontario instead of going outside.

THOUGH OUTPUT of central stations in Canada established a new record in 1930, anticipations were that the 1931 figures would bear a closer relationship to industrial activity. Monthly figures issued by the government now indicate that the current year's production will be well below that in 1930, unless there is a marked pick-up in the last half of the year. The total output amounted to 6,999,405,000 kw.-hr. for the first five months of this year, compared with 7,515,336,000 for the corresponding period last year. Of the output this year, 6,890,157,000 kw.-hr. were generated by water power and 109,248,000 by fuel. For the same period in 1930 output generated by water power totaled 7,380,448,000 kw.-hr. and by fuel 134,888,000.

The returns for May this year, which are the latest available monthly figures, show that output of all central stations in that month amounted to 1,359,772,000

kw.-hr. This compares with 1,544,627,000 kw.-hr. in the same month a year ago, and is one of the lowest monthly figures recorded since 1928.

FROM A RELIABLE SOURCE in Winnipeg comes the information that plans are being discussed for the investment of $30,000,000 in water-power development and in the building up of a huge pulp and paper industry in the province of Manitoba. It is stated that powerful financial interests in Chicago are behind the scheme. The proposed plan would involve the development of a power project either on the Dauphin River or at Grand Rapids, construction of pulp and paper mills in the inter-lake area north of Gypsumville, and the building of a direct rail line linking Winnipeg with Churchill Harbor in the far north. The negotiations are being carried on between Thomas J. McManus, representing the Chicago interests and Donald G. McKenzie, provincial minister of natural resources.

Warren B. Lewis Dies; Was Power Plant Consultant

WARREN B. LEWIS, consulting engineer of Providence, R. I., who for the last 35 years had specialized in the design and operation of industrial power plants died on July 18. He was 61 years old.

Mr. Lewis was born at Providence in April, 1870. After completing his education, he worked in the laboratory at Cornell University with Professor W. A. Anthony on mechanical and electrical problems. He then spent two years in the experimental department of the Thomson Electric Welding Company, two years as engineer with the General Electric Company, and one year as manager of central stations for the United Traction & Electric Company. In 1896 he opened his own office in Providence as a consultant on power plant problems. He was widely known for his work in the design, personnel organization and operating efficiency of industrial installations, and had contributed several articles on these subjects to *Power*.

He was a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers and the Providence Engineering Society.

Homer E. Niesz, Chicago Power Pioneer is Dead

HOMER ELDREDGE NIESZ, manager of industrial relations of the Commonwealth Edison Company, and a pioneer in the development of electric light and power in Chicago, died at the Illinois Central Hospital Aug. 7 of peritonitis, which developed after an appendicitis operation. He was 63 years old.

Born in Canton, Ohio, Mr. Niesz was graduated from Mount Union College in 1886. Shortly after he started as a lineman of the old Chicago Edison Company, after two years of various work he was appointed assistant superintendent of construction, and in 1889 became assistant to the general manager. Other promotions followed, such as assistant to the vice-president in charge of construction and in 1921 he was made manager of industrial relations.

Mr. Niesz was an active member of most of the business and technical organizations connected with the electric light and power industry. He had served as president of the National Safety Council, Western Society of Engineers, The Electric Club of Chicago, and the Chicago Engineers' Club. He took a prominent part in the work of the Electric Association of Chicago and the American Institute of Electrical Engineers, the Illuminating Engineering Society, the Industrial Relations Association of America, and the National Electric Light Association.

COMING CONVENTIONS

American Society of Mechanical Engineers. Regional meeting in Kansas City, Mo., Sept. 7-9. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Association of Engineers. Seventeenth annual convention at Huntington, W. Va., Sept., 28-30. Secretary, M. E. McIver, Willoughby Tower, Chicago, Ill.

American Institute of Electrical Engineers. District meeting at Lake Tahoe, Calif., Aug. 25-28. District meeting at Kansas City, Mo., Oct. 22-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Welding Society. Fall meeting at the Copley-Plaza Hotel, Boston, Mass., Sept. 21-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Edison Illuminating Companies. Forty-seventh annual meeting at The Greenbrier, White Sulphur Springs, W. Va., Sept. 21-25. Secretary, Preston S. Millar, 80th St. and East End Ave., New York City.

International Railway Fuel Association. Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

Southwest Power Conference and Show will be held in Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, George F. Klein, Chamber of Commerce, Kansas City, Mo.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Personals

P. W. THOMPSON has been appointed chief engineer of power plants of the Detroit Edison Company to succeed the late JOHN R. WILDE. Mr. Thompson will be in charge of the production department with responsibility for the operation and maintenance of the company's steam power plants and for such engineering and design of new plant facilities as may from time to time be assigned to him.

OTHMAR KARL MARTI, formerly chief engineer of the American Brown Boveri Company, Camden, N. J., is now associated with the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., in the capacity of engineer in charge of rectifiers and railway equipment. As reported in *Power* some time ago, the America Brown Boveri Company has been purchased by the Allis-Chalmers Company, and many of the American Brown Boveri staff are now with Allis-Chalmers.

A. W. LEONARD resigned on Aug. 10 as chairman of the board and director of the Puget Sound Power & Light Company, a subsidiary of the Engineers Public Service Corporation. He did so "in accordance with the new practice of the Engineers Public Service Corporation, which eliminates that office and vests all executive responsibility in the presidents of the local subsidiaries," J. F. McLaughlin, president of the company stated. Mr. Leonard was formerly president of the Puget Sound company, but resigned several months ago to become chairman of the board. He is succeeded on the board by W. H. McGrath.

AMOS J. MURTHA has been appointed district manager of the Niagara, Lockport & Ontario Power Company, a subsidiary of the Niagara Hudson Power Corporation. For the past fifteen years Mr. Murtha has been connected with the Northern New York Utilities, Inc., in Rome and Camden, N. Y. He moved to Rome in 1916 from Utica as chief engineer of power plants for the Rome Gas, Electric Light & Power Company, which was acquired by the Northern New York Utilities. He has also served as sales supervisor in the Rome district.

WILLIAM P. HAMMOND has been appointed engineer for the Atlanta district of Allied Engineers, Inc., to succeed LEO. N. BLAGOVESCHENSKY, resigned. Mr. Hammond will be in charge of all engineering work done by Allied Engineers for account of the Georgia Power Company.

EARLE H. MORRIS, chief engineer of the Board of Railroad Commissioners of North Dakota, has resigned to join the West Virginia Public Service Commission in the same capacity. Mr. Morris has been chief engineer of the North Dakota commission since 1919.

Business Notes

LACLEDE CHRISTY CLAY PRODUCTS COMPANY, St. Louis, Mo., announces the purchase for $2,000,000 of all of the assets of the BUCKEYE CLAY PRODUCTS COMPANY, Toledo, Ohio, and the WALSH CLAY PRODUCTS COMPANY, St. Louis. The new combination, operating under the control of the Laclede Christy company, will be one of the largest manufacturers of refractories in the country.

THE CONDENSER CORPORATION OF AMERICA, Jersey City, N. J., announces the appointment of the Industrial Products Sales Corporation, 7307 Natural Bridge Road, St. Louis, Mo., as its sales representative in the St. Louis territory for power factor corrective equipment. Joe E. Jury is vice-president and general manager of the St. Louis company.

E. F. HOUGHTON & COMPANY, Philadelphia, Pa., announces the revival of the *Houghton Line*, the aggressive little monthly that was for almost twenty years one of the most widely read of the one-man magazines. Its publication was discontinued in 1929 after the death of Charles E. Carpenter, president of the company, who edited it and made it famous. The first issue of the new *Houghton Line* will appear in September, edited by Louis E. Murphy, who is now president of the company.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces the appointment of T. R. Langan as manager of the northeastern district of the company, with headquarters in New York City. Mr. Langan has been with the company for more than twenty years, serving in the engineering, construction, service and sales departments.

A. M. BYERS COMPANY, Pittsburgh, Pa., has taken a six months' option to purchase the CANONSBURG STEEL & IRON WORKS, Canonsburg Pa. The Canonsburg company, which is controlled by the EDWARDS MANUFACTURING COMPANY, Cincinnati, Ohio, was founded in 1902 and has an annual capacity of 38,000 tons of black sheets and 16,000 tons of galvanized sheets. It is understood that the company will roll wrought-iron sheets in an experimental way for the Byers organization during the next few months.

BAKELITE CORPORATION, New York City, announces the appointment of Martin, Hoyt & Milne, Merchants Exchange Building, San Francisco, Calif., as the agent for its products supplied to varnish manufacturers in the West Coast territory. The Electrical Specialty Company, 1575 Folsom St., San Francisco, retains the agency, in the Pacific Coast territory, for all other existing Bakelite products. Martin, Hoyt & Milne have branch offices at Los Angeles, Portland, and Seattle.

How's Business?

COMMODITY MARKETS have been converted to the 5 and 10 cent idea, with rubber, cotton and copper under 10 cents, according to *The Business Week*, Aug. 19. Our index nevertheless rose, slight upward fluctuations in carloadings, steel, bank debits happening to coincide. Steel production probably hit bottom in July. There are hopes that autumn may drag the industry out of the mire. The copper industry faces an extensive shut-down. Though production is slow, consumption is slower. The oil industry is making heroic efforts to keep production above the rising demand of consumers and is succeeding all too well.

Production of electricity by public utilities for the week ended Aug. 8 was 1,642,858,000 kw.-hr., according to N.E.L.A. figures. This shows a slight decrease from the previous week and is 2.9 per cent below the corresponding period of last year.

Trade Catalogs

CARBON BRUSHES—Specifications and prices of carbon, graphite and metal-graphite brushes, and other carbon products, are given in illustrated catalog No. B-5 recently issued by the United States Graphite Company, Saginaw, Mich. Information on the standardization of carbon brushes and suggestions for eliminating troubles are included.

AIR HEATERS AND REFRACTORIES—Babcock & Wilcox Company, 85 Liberty St., New York City, has just issued five new bulletins on the following equipment and accessories: vertical tubular air heaters for boilers; special process equipment which includes riveted and welded pressure vessels, tubular units, penstock piping, bends and forgings; No. 80 insulating firebrick for furnaces; No. 80 refractory cements and plastics; and No. 80 laboratory furnace.

SPEED REDUCERS—A new 128-page illustrated catalog on speed reducers has just been issued by the Horsburgh & Scott Company, 5114 Hamilton Ave. N. E. Cleveland, Ohio. Descriptions are given of eight types of worm-gear reducers, three types of herringbone gear reducers and the "Heli-Spur" reducer, together with engineering data involved in the design and selection of speed reducers.

PIPING AND VALVES—Bulletin No. 44, recently issued by the Semet-Solvay Engineering Corporation, 40 Rector St., New York City, describes and illustrates the company's welded piping and pipe fittings; also gate, check and butterfly valves, and cooling coils. Tables of standards for fittings are included together with suggestions for efficient planning of new piping and diagrams of operating arrangements for valves.

BOILERS — Combustion Engineering Corporation, 200 Madison Ave., New York City, has just issued illustrated catalog No. SG-1 describing the "Combustion Steam Generator," a pulverized-fuel-fired unit with water-cooled furnace, which is available in eight standard sizes providing capacities from 75,000 to 400,000 lb. of steam per hour at pressures up to 450 lb. A novel arrangement on these generators provides for regulating the temperture of the superheated steam under all conditions.

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Fuel Prices

FUEL OIL

Boston—Aug. 11, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.85c. per gal.

New York—Aug. 13, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 3.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 5c. per gal.

Philadelphia—Aug. 8, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—Aug. 8, f.o.b. local refinery, fuel oil, 30@34 deg., 2.375c.@2.625c. per gal.; 36@40 deg., 2.375c.@2.625c. per gal.

Cincinnati — Aug. 11, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Aug. 8, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 22.5c. per bbl.; 22@24 deg., 25c. per bbl.; 24@26 deg., 27.5c. per bbl.; 26@28 deg., 32.5 per bbl.; 28@30 deg., 37.5 per bbl.

St. Louis — Aug. 10, tank-car lots, f.o.b. St. Louis, 24@26 deg., 99.5c. per bbl., or 42 gal.; 26@28 deg., $1.045 per bbl.; 28@30 deg., $1.12 per bbl.; 30@32 deg., $1.17 per bbl.; 32@36 deg., gas oil, 2.401c. per gal.; 38@40 deg., distillate, 2.901c. per gal.

Dallas—Aug. 8, f.o.b. local refinery 24@26 deg., 75c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol..	New York...	$1.60 @$1.80
Pool 10, h. gr. low vol.	New York...	1.50 @ 1.60
Pool 11, low-vol.....	New York...	1.35 @ 1.45
Smokeless, mine-run..	Chicago.....	1.50 @ 1.75
Smokeless, slack.....	Chicago.....	.50 @ 1.10
Harlan, Ky., slack....	Chicago.....	.85 @ 1.10
Franklin, Ill., mine-run	Chicago.....	2.15
Franklin, Ill., screen...	Chicago.....	1.10 @ 1.60
Ind. 5th Vein, m.-r....	Chicago.....	1.20 @ 1.75
Standard Ill., mine-run	St. Louis.....	1.25 @ 1.40
W. Ky., mine-run....	Louisville....	.85 @ 1.00
W. Ky., slack.....	Louisville	.60 @ .75
Pittsburgh, mine-run.	Pittsburgh....	1.25 @ 1.45
Smokeless, mine-run..	Cincinnati...	1.60 @ 1.75
Smokeless, slack.....	Cincinnati...	.75 @ 1.10
Kanawha, mine-run..	Cincinnati...	.90 @ 1.25
Kanawha, nut-slack.	Cincinnati...	.50 @ .75
Anthracite (Net Tons)	**At Mine, for Shipment to**	**Price per Ton**
Buckwheat.....	New York...	$3.25
Barley.....	New York..	.90 @ 1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Conn., Willimantic — Windham County Memorial Hospital, G. E. Taylor, Chn., will receive bids in late fall for the construction of a hospital, nurses' home, power plant and laundry at West Main and Mansfield Sts. Estimated cost $500,000. Crow, Lewis & Wick, 200 5th Ave., New York. C. S. Neergard, 512 5th Ave., New York, is engineer.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., Chicago, Ill., awarded contract for substation equipment, transformers, etc., to Allis-Chalmers Mfg. Co., West Allis, Wis. $460,000.

Ind., Fort Wayne—St. Vincents Home, will receive bids until Aug. 26 for the construction of an orphans home including school, power plant, etc., at Wells and Archer Aves. Estimated cost $500,000. A. M. Strauss, 415 Cal-Wayne Bldg., is architect. R. W. Noland, 408 Cal-Wayne Bldg., is engineer.

Kan., Topeka—Fleming-Wilson Mercantile Co., 116 Kansas Ave., will soon award contract for the construction of a 1 story, 160 x 160 ft. warehouse including refrigerating plant and cold storage rooms at Euclid Ave. and Santa Fe R.R. Estimated cost $100,000. Austin Co., 510 North Dearborn St., Chicago, Ill., is architect.

Ky., Grayson—Grayson Water Co. will receive bids until Aug. 27 for the construction of a complete waterworks and distribution system including filter and pumping plant, etc. H. K. Bell, 727 McClelland Bldg., Lexington, is consulting engineer.

Ky., Louisville—Louisville Gas & Electric Co., T. B. Wilson, Pres., 311 West Chestnut St., will build a 26 x 31 ft. sub-station on Young St., north of Payne St. to house 1,000 kw. mercury arc rectifier: outdoor sub-station at Seventh St. between Eleventh and Twelfth Sts., to house 25,000 kw. power transformer additions and improvements to existing sub-station at Stevens Ave. west of Bardstown Rd. and high tension transmission line extending from Ohio Falls hydro-electric plant to new Seventh St. sub-station. Estimated total cost $500,000. Work will be done by owner's forces.

Mass., Boston — City Ice & Fuel Co., 68 Lowell St., awarded contract for a 1 story, 100 x 250 ft. ice plant to Pitman & Brown Co., 11 Washington St., Salem. Estimated cost $40,000.

Mass., Boston — Professional Arts Building Inc., W. J. McDonald, 260 Tremont St., awarded contract for superstructure of professional arts building at Dartmouth, and Stuart Sts. and Trinity Pl., to W. M. Evatt Co., 38 Chauncy St., Boston. Estimated cost $4,000,000.

Mass., Cambridge (Boston P. O.)—City will soon receive bids for the construction of a filter plant and pumping station in connection with waterworks improvements. Estimated cost $100,000. Fuller & Everett, 25 West 43rd St., New York, N. Y., are engineers.

Mass., Grafton — Commonwealth of Massachusetts, Dept. of Mental Diseases, is having plans prepared for renewing steam lines at State Hospital. Estimated cost $53,000. R. D. Kimball Co., 6 Beacon St., Boston, is engineer.

Mass., Quincy — Commonwealth of Massachusetts, Metropolitan District Commission, Sewerage Division, will receive bids until Aug. 20 for the construction of Squantum pumping station, receiving reservoir, pump well, mains, etc., in connection with sewage system.

Mich., Selfridge Field—Constructing Quartermaster, will receive bids until Aug. 27 for the construction of a boiler house. Estimated cost $60,000.

Mo., St. Louis—Water Department, awarded contract for furnishing and erecting one 400 kw. d.c. and one 200 kw. a.c. direct connected steam engine driven generator at Sanitarium power house of St. Louis waterworks to Mattoon Engine Works, Mattoon, Ill., $26,883.

Neb., Coleridge—City will soon award contract for the construction of a sanitary sewer system including disposal plant, sewage pumping plant, two 50 g.p.m. non-clogging centrifugal pumps, etc. Estimated cost $37,107. Henningson Engineering Co., Union State Bank Bldg., Omaha, Neb., is engineer.

Neb., South Sioux City—Central West Public Service Co., J. Malory, Third and Waley Way, Sioux City, Ia., plans to rebuild ice plant destroyed by fire here. $100,000.

N. H., Concord—New Hampshire State Hospital, W. A. Stone, Purch. Agt., State House, will receive bids until Aug. 25 for the construction of a power plant. Estimated cost $40,000. R. D. Kimball Co., 6 Beacon St., Boston, Mass., is engineer.

N. J., Hackensack—Bd. of Chosen Freeholders, O. M. Hurd, Chn., Court House, received lowest bid for the construction of a central heating plant on Hudson St. from Potterton Bros., Main St., Closter. $58,800. Tilton, Schwanewede & Githens, Lexington Ave., New York, N. Y., are architects.

N. J., Orange—Board of Commissioners, City Hall, plans the construction of a water pumping station and electric light plant. Estimated cost $425,000. Engineer not selected.

N. Y., New York—Bd. of Transportation, J. H. Delaney, Chn., 250 Hudson St., awarded contract for furnishing and installing power equipment for Concourse line of Independent system of city-owned railroad, Manhattan and Bronx Boroughs to General Electric Co., 120 Broadway. $1,643,557.

N. Y., New York — Five Hundred Seventy-Three First Ave. Corp., 575 First Ave., plans the construction of a meat packing and cold storage plant. Estimated cost to exceed $25,000. R. Shutkind, 147 4th Ave., is architect.

N. Y., New York — Long Island R.R. Co., Pennsylvania Station, awarded contract for electrical equipment, rectifiers, etc., to Allis Chalmers Mfg. Co., West Allis, Wis., and 50 Church St., New York. Estimated cost $350,000. A. C. Watson is chief engineer.

O., Cleveland — Hughes Provision Co., W. Hughes, Pres., 3199 West 65th St., had plans prepared for a 1 and 2 story, 47 x 63 ft. boiler house. Estimated cost $40,000. H. M. Morse & Co., Finance Bldg., are architects and engineers.

Pa., Middletown—Constructing Quartermaster, will receive bids until Aug. 28 for the construction of a boiler house and pipe tunnel.

Tex., Columbus—Central Power & Light Co., c/o E. B. Neiswanger, Alamo National Bank Bldg., San Antonio, is having preliminary plans prepared for the construction of a dam and electric power development 800 hp. capacity on Colorado River.

Tex., Crystal City — City is receiving proposals for the erection and equipping of electric light and power plant to include Diesel engine generating unit, etc. Private plans.

B. C., Vancouver—British Columbia Electric Railway & Gas Co., 425 Carroll St., awarded contract for the construction of a new gas plant consisting of a complete coal and gas unit including blending plant, wharf, coal handling plant, etc., to Gas Chamber & Coke Ovens, Ltd., London, England. $700,000. Condensers, exhausters, scrubbers and purifiers not yet let.

Equipment Wanted

Boiler, Stoker, etc.—Howard, R. I.—State Public Welfare Commission, will receive bids until Aug. 31 for a 500 hp. cross drum water tube boiler, brick setting, underfeed inclined grate multiple retort stoker, etc., for central power plant.

Boilers, Superheaters, Pumps, Etc.—Fort Wayne, Ind.—Board of Public Works, will receive bids until Sept. 3 for two water tube steam boilers with superheaters, air heaters, etc., two multiple retort underfeed mechanical stokers, two forced draft fans and two induced draft fans, three boiler feed and six centrifugal pumps, etc., for proposed improvements to light and power plant.

Converter, Transformer and Switching Equipment—Cleveland, O.—City will receive bids until Aug. 21 for rotary converter with transformer and complete switching equipment.

Generator—Boston, Mass.—Boston Excelsior Co., 45 Washington St. N., plans to purchase a 100 kw. 220 v., 3 ph., 60 cycle generator with direct connected exciter.

Power Plant Equipment, etc.—Trenton, N. J.—Dpt. of Institutions & Agencies, State Office Bldg., is receiving bids for furnishing and installing power plant steam piping and equipment at New Jersey State Prison.

Turbine, Pumps, Transformers, Switches, Etc.—Washington—Dept. of Interior, Bureau of Reclamation, Denver, Colo., will receive bids until Sept. 11 for one 4,200 hp. vertical hydraulic turbine with governor and governor pumps, 3,000 kva. a.c. generator complete with direct connected exciter, 3,000 kva. 3 ph., 2,300 to 39,000/69,000 Y v. transformer, three 500 kva. single ph., 66,000 to 2,400 v. transformers, three or six 69,000 v. lightning arresters, two 69,000 v. air break switches, horizontal centrifugal pump, switchboards, etc., for Prosser power plant and Kennewick Highlands pumping plant, Yakima project, here.

Industrial Projects

Ga., Rossville—Peerless Woolen Mills is having plans prepared for the construction of a 3 story, 100 x 300 ft. woolen mill. W. H. Sears, James Bldg., Chattanooga, Tenn., is architect.

Ga., Trion—Trion Co., Trion or Riegel Textile Corp., 342 Madison Ave., New York, N. Y., awarded contract for the construction of a textile plant here, to A. K. Adams, 542 Plum St N. W., Atlanta, Ga. Estimated cost to exceed $200,000.

Ill., Chicago—Pressed Steel Car Co., Farmers Bldg., Pittsburgh, Pa., awarded contract for the construction of plant here to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $60,000.

Ill., East St. Louis—Virginia-Carolina Chemical Co., Richmond Trust Bldg., Richmond, Va., awarded contract for the construction of a fertilizer plant here to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $100,000.

Ind., Fort Wayne—Zollner Machine Co., awarded contract for a 1 story, 50 x 150 ft. factory on Bueter Road to Buesching & Hagerman Co., 402 East Superior St. Estimated cost $45,000.

Mich., Detroit—Chrysler Motor Car Corp., Massachusetts Ave., Highland Park, awarded contract for a 1 story, 192 x 240 ft. factory for the manufacture of automobile parts and assembly of autos at Mount Elliott Ave. and Lynch Road, to H. G. Christman-Burke Co., 1010 Fisher Bldg.

Minn., St. Paul — Brown & Bigelow, C. A. Ward, Gen. Mgr., Quality Park, is having plans prepared for the construction of a factory for the manufacture of playing cards. Estimated cost $250,000. Toltz, King & Day, 1212 Builders Exchange, are architects.

N. Y., New York—National Screen Service, Inc., 126 West 46th St., manufacturers of film, will receive bids late August for the construction of a 7 story, 98 x 100 ft. factory and office at 346 West 40th St. Estimated cost $250,000. Berlinger & Kaufman, 232 Madison Ave., are architects.

O., Galion — Gledhill Road Machinery Co., E. C. Gledhill, Pres., will soon award contract for the construction of a 1 story, 90 x 200 ft. factory. Estimated cost $50,000. Wallace H. Hatch, Hippodrome Annex Bldg., Cleveland, is architect.

Pa., Ambridge—Spang Chalfant & Co., G. Fisher, Pres., Clark Bldg., Pittsburgh, will receive bids about Aug. 18 for the construction of a 1 story, 125 x 500 ft. experimental electric weld pipe mill here. Private plans.

Tex., Gonzales—Coen Co. Inc., Death Valley, Calif., and Gonzales, Tex., plans the construction of a kaolin plant. Will mine about 75 cars monthly for shipment to oil refineries here. Estimated cost $60,000. Private plans.